United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
North Dakota Agricultural
Experiment Station, North
Dakota Cooperative
Extension Service, and
North Dakota State Soil
Conservation Committee

Soil Survey of Sheridan County, North Dakota

How To Use This Soil Survey

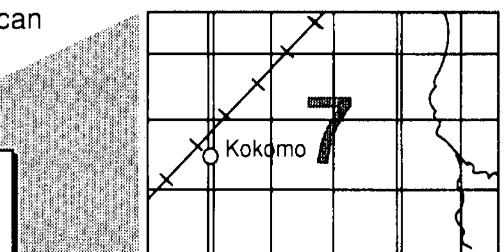
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

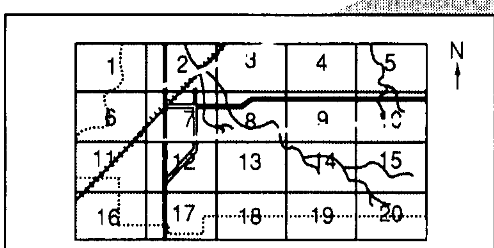
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



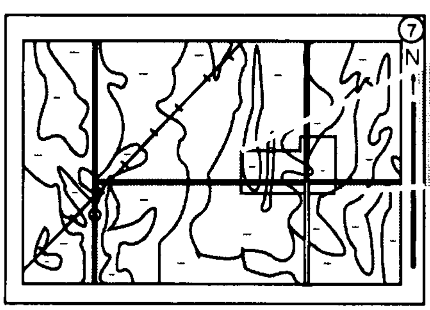
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

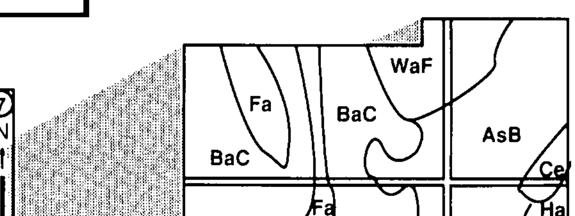


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1989. Soil names and descriptions were approved in 1990. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1989. The flight for the photo base was in 1978. This survey was made cooperatively by the Soil Conservation Service, the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee. It is part of the technical assistance furnished to the Sheridan County Soil Conservation District. Financial assistance was provided by the Sheridan County Soil Conservation District, the Sheridan County Water Resource Board, the Sheridan County Board of Commissioners, and the North Dakota Department of University and School Lands.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: An area of Barnes and Svea soils where a farmstead and feedlot are protected by windbreaks. The ponded Southam soils in the near background provide habitat for wetland wildlife. Barnes and Buse soils are on the hills in the far background.

Contents

Issued November 1994

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Sheridan County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Sheridan County, North Dakota

By Frederick P. Aziz and Robert Lisante, Soil Conservation Service

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United States Department of Agriculture, Soil Conservation Service, in cooperation with North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service, and North Dakota State Soil Conservation Committee

Sheridan County is in the central part of North Dakota (fig. 1). It has a total area of 643,700 acres, of which 633,380 acres is land, 10,000 acres is bodies of water more than 40 acres in size, and 320 acres is bodies of water less than 40 acres in size. The county is bounded on the south by Burleigh and Kidder Counties, on the east by Wells County, on the north by Pierce and McHenry Counties, and on the west by McLean County. The county seat is McClusky, which is in the south-central part of the county.

The county is in the Northern Great Plains Spring Wheat Region. The southwestern third of the county is on the Central Dark Brown Glaciated Plains, and the northeastern two-thirds is on the Central Black Glaciated Plains *(18)*.

The first soil survey of the area now known as Sheridan County was published in 1910, in a survey of western North Dakota *(10)*. A general soil map of Sheridan County was published in 1963 and described in a report published in 1968 *(12)*. The county also was included in another general soil map and report published in 1968 *(11)*. An interim survey of the Lincoln Valley area of Sheridan County, an area of about 28,500 acres, was published in 1974 *(14)*. The present survey updates the earlier surveys. It provides additional information and generally shows the soils in more detail.

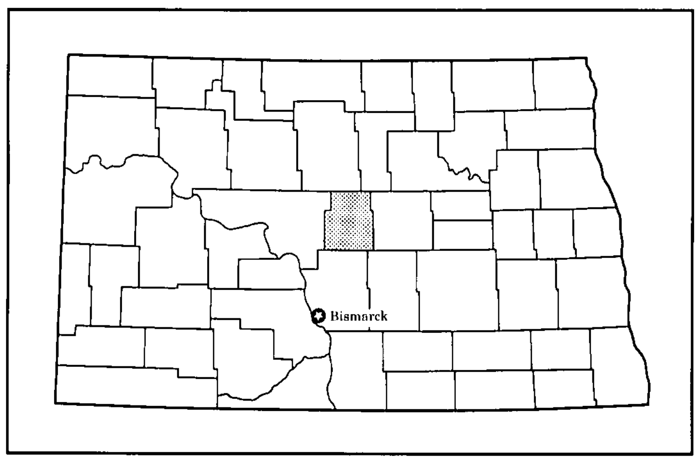

Figure 1.—Location of Sheridan County in North Dakota.

General Nature of the County

This section provides general information about Sheridan County. It describes climate; physiography, relief, and drainage; history and development; farming and ranching; and natural resources.

Climate

Sheridan County is usually quite warm in summer. It has frequent spells of hot weather and occasional cool days. It is very cold in winter, when arctic air frequently surges over the survey area. Precipitation falls mainly during the warm period and is normally heaviest in late spring and early summer. Winter snowfall is normally not too heavy, and it is blown into drifts, so that much of the ground is free of snow.

Several times each winter, storms with snow and high winds bring blizzard conditions to the survey area. Hail falls during summer thunderstorms in scattered small areas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at McClusky in the period 1951 to 1987. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 11 degrees F and the average daily minimum temperature is 2 degrees. The lowest temperature on record, which occurred at McClusky on January 29, 1951, is -38 degrees. In summer, the average temperature is 68 degrees and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred on July 11, 1973, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 18 inches. Of this, nearly 14 inches, or about 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 12 inches. The heaviest 1-day rainfall during the period of record was 4.24 inches on June 30, 1975. Thunderstorms occur on about 34 days each year.

The average seasonal snowfall is about 34 inches. The greatest snow depth at any one time during the period of record was 26 inches. On the average, 51 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 12 miles per hour, in spring.

Physiography, Relief, and Drainage

The county is in the Missouri Coteau and Glaciated Plains regions of the Central Lowland Province (fig. 2). The Missouri Escarpment extends from northwest to southeast across the northern part of the county, separating the two regions. It is a dissected, north-facing escarpment that is 200 to 400 feet high.

The Glaciated Plains include about 175 square miles of nearly level to undulating glacial topography characterized by poor surface drainage. Typical landforms include till-draped areas, ice-thrust features, and moraines that are collapsed to various degrees. The landforms have been modified by running water, which has washed the surface in some areas and deposited gravel and sand in others. The Sheyenne River meltwater trench crosses this area. Local relief is less than 5 feet in many places, although it is more than 150 feet near the Sheyenne River trench *(4)*.

The Missouri Coteau covers the southern two-thirds of the county. It is a strip of hills, 15 to 50 miles wide, that resulted from large-scale glacial stagnation. Typical landforms include moraines, flood plains, and lake plains; elevated lake plains; and various types of disintegration ridges. This area is characterized by poor surface drainage and numerous sloughs, lakes, and closely spaced hills. Many depressions receive runoff from the higher nearby areas. The Missouri Coteau in Sheridan County forms the Continental Divide between Hudson Bay drainage to the northeast and Gulf of Mexico drainage to the southwest.

The natural drainage pattern is poorly defined in most of the county. The Sheyenne River, which originates in the northern part of the county, is the only established outlet for runoff. This river was established by glacial meltwater. At present, there is enough runoff to flow in the river only in spring and in years when the amount of rainfall is above normal.

Elevation ranges from about 1,600 feet in an area where the Sheyenne River leaves the county to more than 2,200 feet in the Prophets Mountains, northwest of McClusky.

History and Development

The settlement of Sheridan County dates back to the 1800's. The survey area was Indian domain. Sioux, Chippewa, and Gros Ventres Indians used the area as

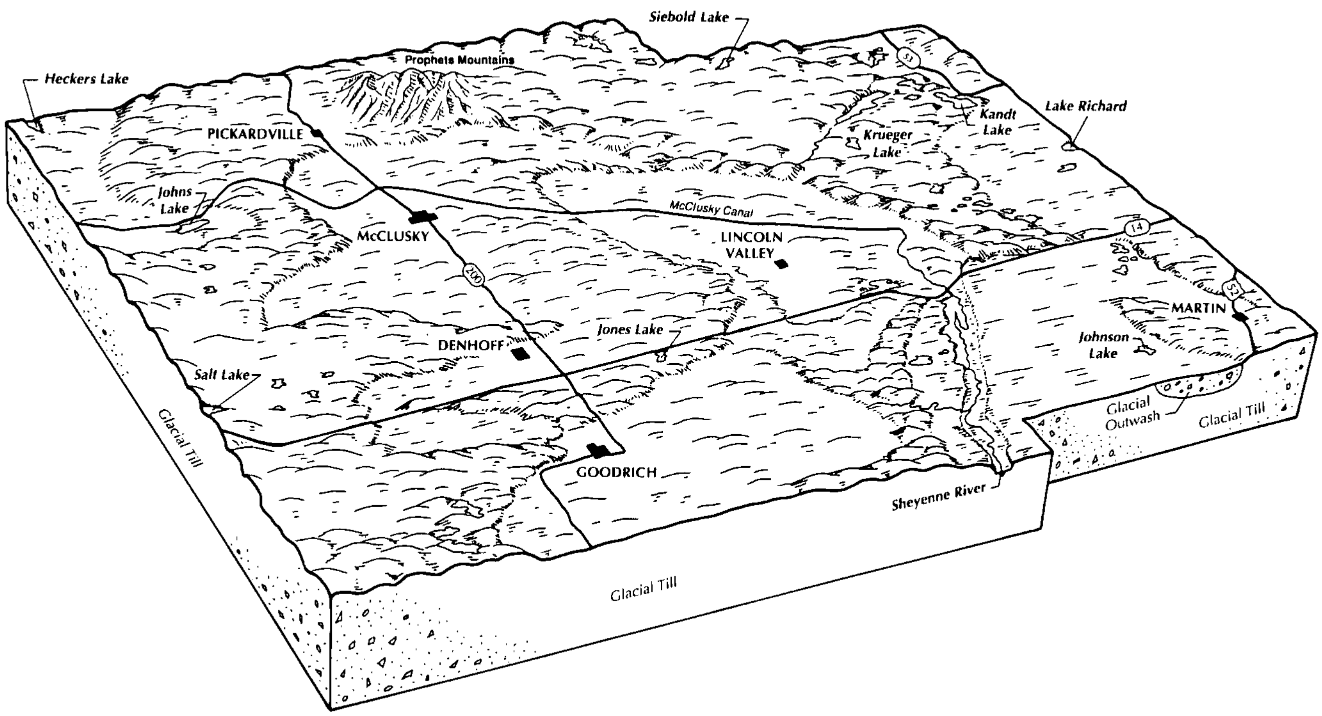

Figure 2.—Physiographic features of Sheridan County, North Dakota.

hunting grounds. Prior to settlement, white hunters and trappers entered the county, but no permanent settlement was established until the early 1880's.

Many heavily traveled trails, both military and civilian, crisscrossed the county. In 1896, the Soo Line Railroad was built through the northeastern part of the county. Martin was the first town in the county. In 1901, the Northern Pacific Railroad was extended into Goodrich. It was extended through McClusky and to the west in 1905.

A few homesteaders filed in 1897. Between 1899 and 1901, the northern part of the county was settled. Settlement of the southern part began in 1902. By 1910, most of the available homestead land had been taken and the railroad grants had been sold. The population gradually increased until 1910, when it reached a peak of 8,103. The population has gradually decreased since 1910 *(19)*. It was 7,373 in 1930 and 2,560 in 1988. McClusky, the largest town, has a population of 658; Goodrich has one of 288; and Martin has one of 114.

Settlers with various backgrounds established themselves in Sheridan County. Protestant Germans from Russia were the largest group. They came from South Dakota at the turn of the century. About 90 percent migrated from Bessarabia. Dobrudja Germans, sometimes called Rumanians, migrated in the early 1880's from colonies along the west edge of the Black Sea. They settled in the northwestern part of the county after staying a short time near Winnipeg, Canada. Ukrainians from Kiev, Russia, also settled in the northwestern part. German Mennonites migrated from the Ukraine after staying in South Dakota for a while. They settled in the south-central and east-central parts of the county *(13)*. Other people came from Norway, Sweden, Denmark, England, Scotland, Ireland, France, and Lebanon (then Syria).

Sheridan County was named for General Philip Henry Sheridan of Civil War fame. Before 1908, it was part of the original McLean County. The county commissioners designated McClusky as the temporary county seat, and the county electorate approved it as their new county seat about 1 year later. The first school was started in Martin in 1897. The first sod church was built in the vicinity of the Lincoln Valley in 1902 *(19)*.

One Federal highway and three State highways provide access to markets. These highways, along with the hard-surfaced and graveled county and township roads, provide a good transportation network. The county is served by two major railroads.

Farming and Ranching

The first settlers in Sheridan County were mainly cattle ranchers. They located in the hilly southern and western parts of the county. The influx of homesteaders transformed the open range for sheep, horses, and cattle by the turn of the century *(19)*.

The number of farms in the county increased until the 1910's, after which it decreased. It decreased from 1,207 in 1910 to 1,083 by 1930 and 470 by 1987.

Currently, most of the farms are diversified and derive income from cow-calf beef or dairy enterprises and from the sale of sheep or of small grain crops. A few farms are used mainly for small grain, and a few ranchers mainly raise cattle. The cattle ranchers grow oats and barley for feed and grasses and legumes for forage.

About 412,000 acres in the county, or 64 percent of the total acreage, is used as cropland. The rest of the county generally supports native grasses and is used for range or hay. The major crop is hard red spring wheat, which yields an average of 25 bushels per acre. Other cash crops are durum wheat, winter wheat, barley, oats, flax, sunflowers, and corn. Small acreages are planted to mustard, buckwheat, rye, sorghum, millet, and safflower. The crops grown as feed for livestock are oats, corn cut for silage, alfalfa, tame grasses, and sweetclover *(8)*.

The Sheridan County Soil Conservation District was organized in 1950. The Soil Conservation Service furnishes technical assistance to the district.

Natural Resources

Soil is the most important natural resource in the county. Livestock that graze the grasslands and crops grown on farms are marketable products that are affected by the soil. Other important natural resources are sand, gravel, and water. Sand and gravel are deposited in many areas in the county. The best gravel, which has a relatively low content of shale, is in the terraces along the Sheyenne River. Good-quality gravel also is in some of the fluvial plain deposits. Most of the gravel in areas of ice-contact deposits, such as eskers, is of poor quality *(4)*.

Sheridan County has adequate water for domestic uses and for use by livestock. The Fox Hills aquifer system is the major bedrock aquifer system in the county. It underlies most of the county and in many areas is the only aquifer system that can produce sufficient quantities of water for domestic uses and livestock. The aquifer system ranges from less than 200 feet to 367 feet in thickness. Aquifers in areas of glacial drift have the best potential for ground-water development. The aquifers include the Lake Nettie aquifer system (lower and upper), the Martin aquifer system, and the Butte, Painted Woods Creek, and North Burleigh aquifers *(5)*.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations or hazards, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used in making this survey are described in the National Soils Handbook of the Soil Conservation Service and in the "Soil Survey Manual" *(15)*. "The Major Soils of North Dakota" *(11)*, "Soil Taxonomy" *(17)*, and "Land Resource Regions and Major Land Resource Areas of the United States" *(18)* were among the references used. The procedures used in determining the nature and characteristics of the soils are described under the heading "How This Survey Was Made."

Soil scientists traversed the land on foot and by pickup or an all-terrain vehicle at an interval close enough for them to locate contrasting soil areas of about 3 to 5 acres. All map units were characterized by transects of representative areas. Generally, one transect was recorded for each 1,000 acres of a given map unit.

Data collected from the transects were used to determine soil names and establish the range of composition of each map unit. The statistical method explained by R.W. Arnold was used *(3)*. This statistical analysis indicates that the map unit composition given in the map unit descriptions is at least 90 percent accurate.

Each map unit was documented by at least one pedon description for each soil series identified in its name. Laboratory data were collected in 1987 and 1988 on 17 pedons sampled for engineering properties. The analyses were made by the North Dakota State Highway Department.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts, the location of moisture regime areas, differing soil patterns, and differences in the design of the associations, some of the soil boundaries and soil names on the general soil map of this county do not match those on the maps of Burleigh, Pierce, McLean, and Wells Counties, North Dakota.

Soil Descriptions

Very Deep, Loamy Soils on Till Plains

These soils formed in glacial till. They make up about 49 percent of the county. Most areas are used for cultivated crops. Some are used for range, pasture, or hay. The soils are well suited to cultivated crops and to range, pasture, and hay. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and maintaining or improving productivity. The main concerns in managing range, pasture, and hayland are achieving a uniform distribution of grazing and maintaining an adequate cover of the native or introduced forage plants.

1. Williams-Bowbells-Zahl Association

Medium textured, nearly level to gently rolling, well drained soils

This association consists of nearly level to gently rolling soils on summits, shoulder slopes, side slopes, and foot slopes on till plains. The landscape is dotted with depressions and light colored knolls and knobs. Slopes are short to long and are complex. They range from 1 to 9 percent.

This association makes up about 11 percent of the county. It is about 51 percent Williams soils, 11 percent Bowbells soils, 10 percent Zahl soils, and 28 percent soils of minor extent (fig 3).

The nearly level to gently rolling Williams soils are on side slopes and summits. Typically, the surface layer is very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of the substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam.

The undulating Bowbells soils are on foot slopes. Typically, the surface layer is black loam about 8 inches thick. The subsoil is clay loam about 22 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, dark grayish brown and calcareous, and grayish brown and calcareous. The upper part of the substratum is grayish brown, calcareous loam. The lower part to a depth of 60 inches is olive brown, calcareous clay loam.

The undulating and gently rolling Zahl soils are on knolls, knobs, and shoulders slopes. Typically, the surface layer is very dark brown loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown and light olive brown clay loam.

Hamerly, Parnell, Southam, Tonka, and Wabek are the principal minor soils in this association. The

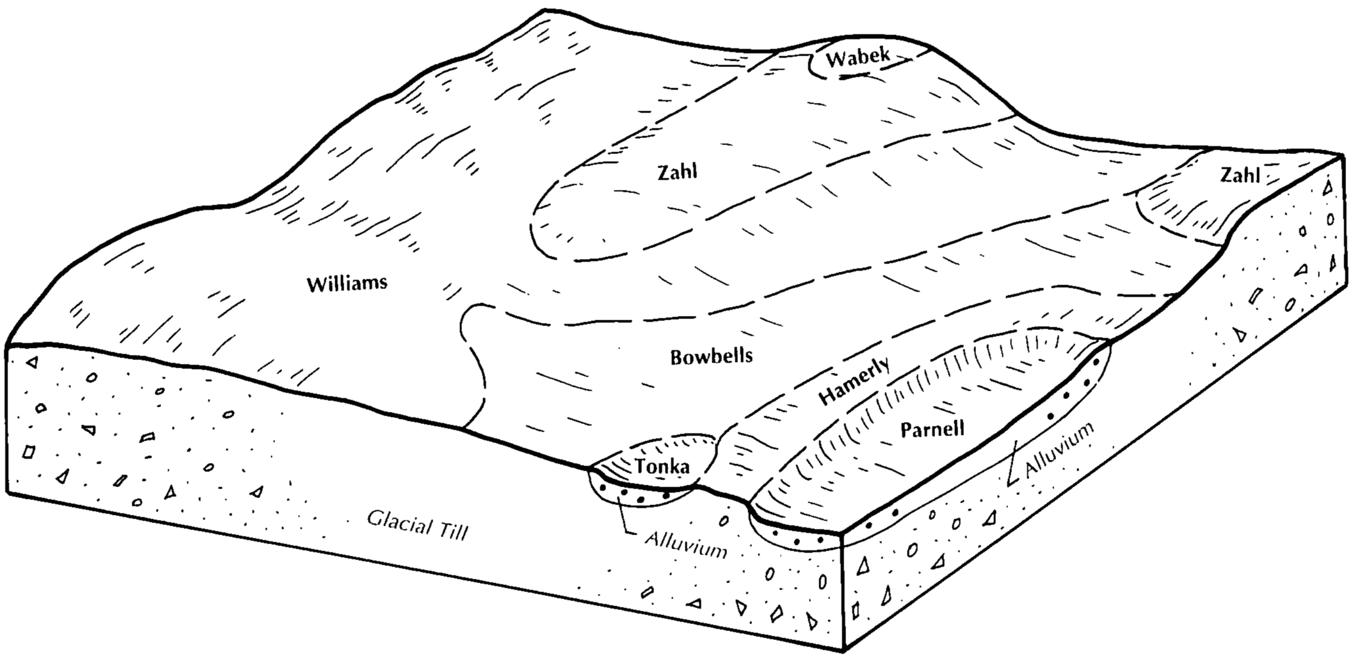

Figure 3.—Typical pattern of soils and parent material in the Williams-Bowbells-Zahl association.

somewhat poorly drained Hamerly soils have an accumulation of lime within a depth of 16 inches. They are on flats surrounding depressions. The very poorly drained Parnell and Southam soils are in deep depressions. Southam soils are almost continuously ponded. The poorly drained Tonka soils are in shallow depressions. The excessively drained Wabek soils have a gravelly substratum. They are on knolls and knobs.

In most areas this association is used for cultivated crops or hay. It is suited to cultivated crops and well suited to hay, range, and pasture. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing range or pasture is maintaining an adequate cover of the native or introduced forage plants.

2. Barnes-Buse-Svea Association

Medium textured, level to gently rolling, well drained and moderately well drained soils

This association consists of level to gently rolling soils on summits, shoulder slopes, side slopes, and foot slopes on till plains. Many scattered depressions and light colored knolls and knobs are throughout most areas. Slopes are short to long and are complex. They range from 0 to 9 percent.

This association makes up about 20 percent of the county. It is about 43 percent Barnes soils, 15 percent Buse soils, 14 percent Svea soils, and 28 percent soils of minor extent.

The level to gently rolling, well drained Barnes soils are on summits and side slopes. Typically, the surface layer is black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam.

The undulating and gently rolling, well drained Buse soils are on light colored knolls and knobs and on shoulder slopes. Typically, the surface layer is black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam.

The level to undulating, moderately well drained Svea soils are on foot slopes. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 39 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and dark grayish brown and calcareous in the lower part. Below this to a depth of about 60 inches is dark grayish brown, calcareous loam.

Cresbard, Hamerly, Parnell, Sioux, Southam, and Tonka are the principal minor soils in this association. The moderately well drained Cresbard soils have a dense, sodic subsoil. They are intermingled with areas of the Svea soils. The somewhat poorly drained Hamerly soils have an accumulation of lime within a depth of 16 inches. They are on flats surrounding depressions. The very poorly drained Parnell and Southam and poorly drained Tonka soils are in depressions. Southam soils are almost continuously ponded. The excessively drained Sioux soils have a gravelly substratum. They are on knolls.

In most areas this association is used for cultivated crops. It is suited to cultivated crops and well suited to range, pasture, and hay. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing range or pasture is maintaining an adequate cover of the native or introduced forage plants.

3. Barnes-Cresbard-Hamerly Association

Medium textured, level to undulating, well drained to somewhat poorly drained soils

This association consists of level to undulating soils on flats and rises and in swales on till plains. Scattered depressions and light colored knolls are throughout most areas. Slopes generally are long and smooth. They range from 0 to 6 percent.

This association makes up about 3 percent of the county. It is about 44 percent Barnes soils, 34 percent Cresbard soils, 7 percent Hamerly soils, and 15 percent soils of minor extent.

The level to undulating, well drained Barnes soils are on rises. Typically, the surface layer is black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam.

The level to undulating, moderately well drained, sodic Cresbard soils are in swales. Typically, the surface layer is very dark gray loam about 6 inches thick. The next layer is very dark grayish brown and dark grayish brown clay loam about 7 inches thick. The subsoil is clay loam about 31 inches thick. It is brown in the upper part, dark grayish brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous, mottled clay loam.

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on flats. Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is light olive brown loam about 21 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Buse, Cavour, Miranda, Svea, and Tonka are the principal minor soils in this association. The well drained Buse soils are calcareous throughout the subsoil. They are on light colored knolls. The moderately well drained Cavour and Svea soils are intermingled with areas of the Cresbard soils. Cavour soils have columnar structure in the subsoil. The somewhat poorly drained Miranda soils have salts within a depth of 16 inches. They are on flats. The poorly drained Tonka soils are in depressions.

In most areas this association is used for cultivated crops. It is suited to cultivated crops and well suited to range, pasture, and hay. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and improving root penetration in the dense subsoil of the Cresbard soils. The main concern in managing range or pasture is maintaining an adequate cover of the native or introduced forage plants.

4. Cathay-Emrick-Larson Association

Medium textured, level to undulating, moderately well drained and somewhat poorly drained soils

This association consists of level to undulating soils on rises and flats and in swales on till plains. Scattered depressions and knolls are throughout most areas. Slopes generally are long and smooth. They range from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 38 percent Cathay soils, 28 percent Emrick soils, 14 percent Larson soils, and 20 percent soils of minor extent (fig. 4).

The level to undulating, moderately well drained, sodic Cathay soils are on rises and flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 39 inches thick. In sequence downward, it is very dark grayish brown, dark brown, light olive brown and calcareous, and light yellowish brown and calcareous. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level to undulating, moderately well drained Emrick soils are in swales. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 36 inches thick. It is very dark grayish brown in the upper part, grayish brown and calcareous in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level and nearly level, somewhat poorly drained, sodic Larson soils are in swales. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is dark gray fine sandy loam about 3 inches thick. The subsoil extends to a depth of 60 inches or more. In sequence downward, it is very dark grayish brown clay loam; dark grayish brown, calcareous clay loam; olive brown, calcareous loam; and olive brown, calcareous clay loam.

Fram, Harriet, Heimdal, Miranda, and Tonka are the principal minor soils in this association. Fram and Miranda soils are somewhat poorly drained. Fram soils have an accumulation of lime within a depth of 16 inches. They are on the rim of depressions. Miranda soils have salts within a depth of 16 inches. They are on flats. Harriet and Tonka soils are poorly drained. Harriet soils have a dense, sodic subsoil. They are on flats. Tonka soils are in depressions. Heimdal soils are well drained and are on rises.

In most areas this association are used for cultivated crops. In some areas it is used for range, pasture, or hay. It is suited to cultivated crops, range, pasture, and hay. The main concerns in managing cultivated areas are controlling water erosion and improving root penetration in the dense subsoil of the Cathay and Larson soils. The main concern in managing range or pasture is maintaining an adequate cover of the native or introduced forage plants.

5. Heimdal-Emrick Association

Medium textured, level to undulating, well drained and moderately well drained soils

This association consists of level to undulating soils on rises and flats and in swales on till plains. Many scattered depressions and knolls are throughout most areas. Slopes generally are long and smooth. They range from 0 to 6 percent.

This association makes up about 13 percent of the county. It is about 54 percent Heimdal soils, 30 percent Emrick soils, and 16 percent soils of minor extent (fig. 5).

The level to undulating, well drained Heimdal soils are on rises and flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part, brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level to undulating, moderately well drained

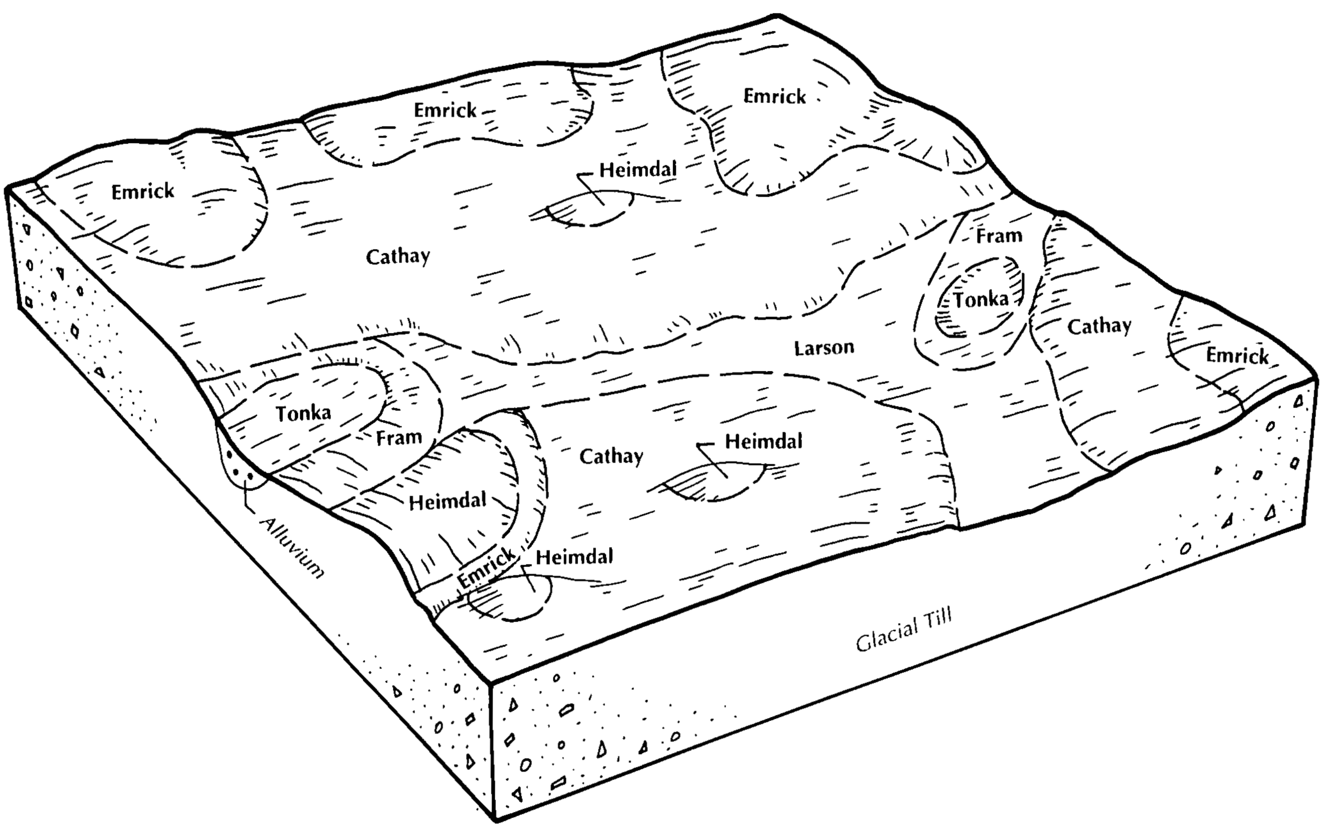

Figure 4.—Typical pattern of soils and parent material in the Cathay-Emrick-Larson association.

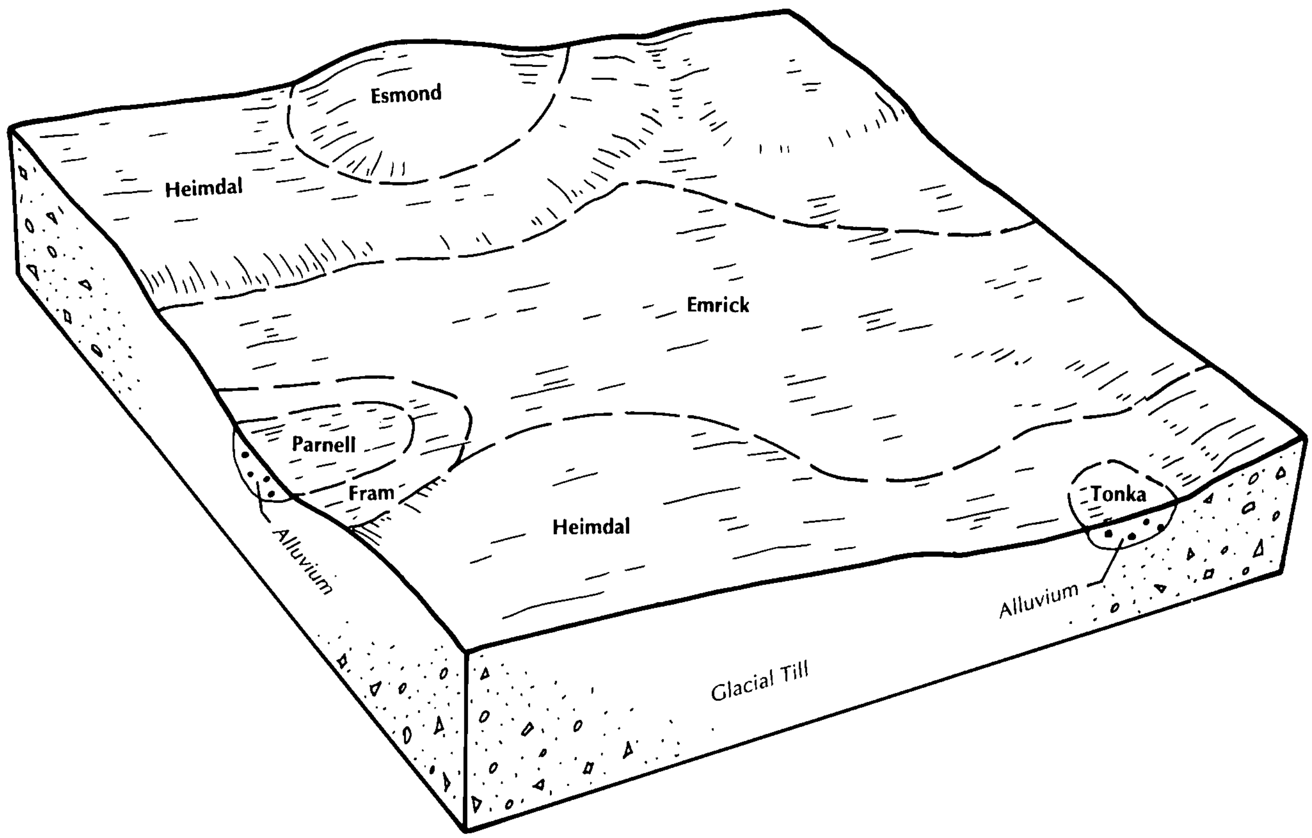

Figure 5.—Typical pattern of soils and parent material in Heimdal-Emrick association.

Emrick soils are in swales. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 36 inches thick. It is very dark grayish brown in the upper part, grayish brown and calcareous in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

Esmond, Fram, Parnell, Swenoda, and Tonka are the principal minor soils in this association. Esmond and Swenoda soils are well drained. Esmond soils are calcareous throughout the subsoil. They are on knolls. Swenoda soils are intermingled with areas of the Emrick soils. Fram soils are somewhat poorly drained and have an accumulation of lime within a depth of 16 inches. They are on flats around depressions. Parnell and Tonka soils are in depressions. Parnell soils are very poorly drained. Tonka soils are poorly drained.

In most areas this association is used for cultivated crops. It is well suited to cultivated crops, range, pasture, and hay. The main concern in managing cultivated areas is controlling water erosion. The main concern in managing range or pasture is maintaining an adequate cover of the native or introduced forage plants. The minor Parnell and Tonka soils are well suited to wetland wildlife habitat.

Very Deep, Loamy and Silty Soils on Till Plains and Moraines

These soils formed in glacial till and alluvium. They make up about 35 percent of the county. Most areas are used as range. Some are used for pasture, hay, or cultivated crops. The soils are well suited to range, pasture, and hay and poorly suited to cultivated crops. The main concerns in managing range are achieving a uniform distribution of grazing and maintaining an adequate cover of the native forage plants. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and maintaining productivity.

6. Esmond-Heimdal Association

Medium textured, gently rolling to steep, well drained soils

This association consists of gently rolling to steep soils on summits, shoulder slopes, and side slopes on till plains and moraines. A few scattered swales, flats, and depressions are throughout most areas. Slopes generally are short and complex. They range from 6 to 35 percent.

This association makes up about 3 percent of the county. It is about 48 percent Esmond soils, 38 percent Heimdal soils, and 14 percent soils of minor extent.

The gently rolling to steep Esmond soils are on shoulder slopes. Typically, the surface layer is black loam about 4 inches thick. The next layer is dark grayish brown, calcareous loam about 5 inches thick. The subsoil is about 17 inches thick. It is dark grayish brown and grayish brown and is calcareous. It is sandy loam in the upper part and loam in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is dark grayish brown in the upper part and olive brown in the lower part.

The gently rolling to hilly Heimdal soils are on summits and side slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part, brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

Arvilla, Emrick, Fram, and Tonka are the principal minor soils in this association. The somewhat excessively drained Arvilla soils are intermingled with areas of the Heimdal soils. The moderately well drained Emrick soils are dark to a depth of more than 16 inches. They are in swales. The somewhat poorly drained Fram soils have an accumulation of lime within a depth of 16 inches. They are on flats around depressions. The poorly drained Tonka soils are in shallow depressions.

In most areas this association is used as range. In the less sloping areas, it generally is used for cultivated crops, pasture, or hay. It is poorly suited to cultivated crops, suited to hay and pasture, and well suited to range. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concern in managing range is maintaining an adequate cover of the native forage plants. The minor Tonka soils are well suited to wetland wildlife habitat.

7. Zahl-Williams-Parnell Association

Medium textured, level to steep, well drained and very poorly drained soils

This association consists of level to steep soils on summits, shoulder slopes, and side slopes and in depressions on till plains and moraines. A few scattered drainageways, swales, and flats are throughout most areas. Slopes generally are short and complex. They range from 0 to 35 percent.

This association makes up about 16 percent of the county. It is about 46 percent Zahl soils, 24 percent Williams soils, 10 percent Parnell soils, and 20 percent soils of minor extent.

The undulating to steep, well drained Zahl soils are on shoulder slopes. Typically, the surface layer is very dark brown, calcareous loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown and light brown, calcareous clay loam.

The nearly level to steep, well drained Williams soils are on side slopes and summits. Typically, the surface layer is very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of the substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam.

The level, very poorly drained Parnell soils are in depressions. Typically, the surface soil is about 13 inches thick. It is black. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay.

Bowbells, Hamerly, Southam, Tonka, and Wabek are the principal minor soils in this association. The well drained Bowbells soils are dark to a depth of more than 16 inches. They are in swales. The somewhat poorly drained Hamerly soils have an accumulation of lime within a depth of 16 inches. They are on flats. The very poorly drained Southam and poorly drained Tonka soils are in depressions. The excessively drained Wabek soils are gravelly. They are on rises and ridges.

In most areas this association is used as range, pasture, or wildlife habitat. In the undulating to hilly areas, it is used for cultivated crops or hay. It is suited to range, pasture, hay, and cultivated crops. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concerns in managing range or pasture are maintaining an adequate cover of the native or introduced forage plants and minimizing the compaction and root shearing resulting from grazing when the Parnell soils are wet. The main concerns in managing the wetland wildlife habitat are preventing siltation and maintaining the natural water level.

8. Buse-Barnes-Parnell Association

Medium textured, level to steep, well drained and very poorly drained soils that are usually moist

This association consists of level to very steep soils on summits, shoulder slopes, and side slopes and in depressions on till plains and moraines. A few scattered flats are throughout most areas. Slopes generally are short and complex. They range from 0 to 35 percent.

This association makes up about 14 percent of the county. It is about 31 percent Buse soils, 26 percent Barnes soils, 10 percent Parnell soils, and 33 percent soils of minor extent.

The undulating to steep, well drained Buse soils are on shoulder slopes. Typically, the surface layer is black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam.

The level to hilly, well drained Barnes soils are on side slopes and summits. Typically, the surface layer is black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam.

The level, very poorly drained Parnell soils are in depressions. Typically, the surface soil is about 13 inches thick. It is black. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay.

Arvilla, Hamerly, Sioux, Southam, and Tonka are the principal minor soils in this association. The somewhat excessively drained Arvilla soils have a gravelly substratum. They are on rises. The somewhat poorly drained Hamerly soils have an accumulation of lime within a depth of 16 inches. They are on flats surrounding depressions. The excessively drained Sioux soils are gravelly throughout. They are on knolls and knobs. The very poorly drained Southam and poorly drained Tonka soils are in depressions.

In most areas this association is used as range, pasture, or wildlife habitat. In some rolling areas it is used for cultivated crops or hay. It is generally unsuited to cultivated crops, is suited to hay and pasture, and is well suited to range. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concern in managing range is maintaining an adequate cover of the native or introduced forage plants. The Parnell soils are well suited to wetland wildlife habitat.

9. Hamerly-Tonka-Southam Association

Medium textured and fine textured, level and nearly level, somewhat poorly drained to very poorly drained soils

This association consists of level and nearly level soils on flats and in depressions on till plains. A scattered few rises are throughout most areas. Slopes generally are short and smooth. They range from 0 to 3 percent.

This association makes up about 2 percent of the county. It is about 38 percent Hamerly soils, 31 percent Tonka soils, 15 percent Southam soils, and 16 percent soils of minor extent.

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on flats on the rim of depressions. Typically, the surface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 21 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level, poorly drained Tonka soils are in shallow depressions. Typically, the surface soil is black silt loam about 11 inches thick. The subsurface layer is very dark gray silt loam about 10 inches thick. The subsoil is very dark grayish brown, mottled silty clay loam about 20 inches thick. The next layer is dark grayish brown, mottled, calcareous silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is olive, mottled, calcareous clay loam.

The level, very poorly drained Southam soils are in deep depressions. Typically, the surface soil about 25 inches thick. It is black, mottled, and calcareous. It is silty clay loam in the upper part and silty clay in the lower part. The substratum to a depth of about 60 inches is dark gray, calcareous silty clay.

Barnes, Fram, Parnell, Svea, and Vallers are the principal minor soils in this association. The well drained Barnes soils are on rises. The somewhat poorly drained Fram and poorly drained Vallers soils have a layer of lime accumulation within a depth of 16 inches. Fram soils are intermingled with areas of the Hamerly soils. Vallers soils are on the inner part of the rim of depressions. The very poorly drained Parnell soils do not have carbonates within a depth of 40 inches. They are in depressions. The moderately well drained Svea soils are dark to a depth of more than 16 inches. They are in swales.

In most areas this association is used for cultivated crops or hay. In some areas it is used as range, pasture, or wildlife habitat. The Hamerly soils and drained areas of the Tonka soils are suited to small grain, flax, and sunflowers. The Tonka soils are best suited to range, pasture, hay, or wetland wildlife habitat. The Southam soils are best suited to wetland wildlife habitat. The main concern in managing cultivated areas is controlling soil blowing. The main concerns in managing range are maintaining an adequate cover of the native forage plants and minimizing the compaction and root shearing resulting from grazing when the soils are wet. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

Very Deep, Loamy Soils on Outwash Plains

These soils formed in glaciofluvial deposits. They make up about 11 percent of the county. Most areas are used for cultivated crops or range. The soils are poorly suited to cultivated crops and well suited to range. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The main concerns in managing range are achieving a uniform distribution of grazing and maintaining an adequate cover of the native forage plants.

10. Wabek-Lehr Association

Moderately coarse textured and medium textured, level to steep, excessively drained and somewhat excessively drained soils

This association consists of level to steep soils on flats, rises, and knolls on collapsed outwash plains. A few scattered depressions and drainageways are throughout most areas. Slopes generally are short and complex. They range from 0 to 35 percent.

This association makes up about 5 percent of the county. It is about 70 percent Wabek soils, 10 percent Lehr soils, and 20 percent soils of minor extent.

The nearly level to steep, excessively drained Wabek soils are on rises and knolls. Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The next layer is dark brown gravelly loamy sand about 5 inches thick. The substratum to a depth of about 60 inches is calcareous very gravelly coarse sand. It is dark grayish brown in the upper part and olive brown in the lower part.

The level to undulating, somewhat excessively drained Lehr soils are on rises and flats. Typically, the surface layer is very dark brown loam about 7 inches thick. The subsoil is loam about 8 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous very gravelly coarse sand.

Arvilla, Maddock, and Marysland are the principal minor soils in this association. The somewhat excessively drained Arvilla soils have a surface layer and subsoil of sandy loam. They are intermingled with areas of the Lehr soils. The well drained Maddock soils have a surface soil and subsoil of loamy fine sand. They are on rises and flats. The poorly drained Marysland soils are in depressions and drainageways.

In most areas this association is used for cultivated crops or range. It is poorly suited to cultivated crops but is suited to range, pasture, and hay. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing range are controlling soil blowing, preventing denuding, and maintaining an adequate cover of the native forage plants.

11. Arvilla-Sioux-Renshaw Association

Moderately coarse textured and medium textured, level to steep, somewhat excessively drained and excessively drained soils

This association consists of level to steep soils on flats, rises, and knolls on collapsed outwash plains. A few scattered depressions are throughout most areas. Slopes generally are short and complex. They range from 0 to 35 percent.

This association makes up about 6 percent of the county. It is about 53 percent Arvilla soils, 24 percent Sioux soils, 10 percent Renshaw soils, and 13 percent soils of minor extent.

The level to hilly, somewhat excessively drained Arvilla soils are on slight rises and flats. Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is sandy loam about 10 inches thick. It is very dark brown in the upper part and dark yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous gravelly coarse sand. It is brown in the upper part and olive brown in the lower part.

The nearly level to steep, excessively drained Sioux soils are on knolls and rises. Typically, the surface layer is black loam about 6 inches thick. The next layer is very dark grayish brown, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is calcareous very gravelly sand. It is dark yellowish brown in the upper part and olive brown in the lower part.

The level to undulating, somewhat excessively drained Renshaw soils are slight rises and flats. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 9 inches thick. It is very dark grayish brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is calcareous very gravelly loamy sand. It is dark brown in the upper part and dark yellowish brown in the lower part.

Divide, Fossum, and Marysland are the principal minor soils in this association. Divide soils are somewhat poorly drained and are on flats. Fossum and Marysland soils are poorly drained. Fossum soils are in depressions. Marysland soils are in slight depressions and drainageways.

In most areas this association is used for cultivated crops or range. It is poorly suited to cultivated crops but is suited to range, pasture, and hay. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing range are controlling soil blowing, preventing denuding, and maintaining an adequate cover of the native forage plants.

Very Deep, Clayey and Silty Soils on Lake Plains

These soils formed in glaciolacustrine deposits. They make up about 2 percent of the county. Most areas are cultivated. The soils are well suited to cultivated crops. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining productivity.

12. Nutley-Overly Association

Fine textured and moderately fine textured, level to undulating, well drained and moderately well drained soils

This association consists of level to undulating soils on rises and flats on lake plains. A few scattered depressions are throughout most areas. Slopes generally are long and smooth. Theyrange from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 55 percent Nutley soils, 24 percent Overly soils, and 21 percent soils of minor extent.

The well drained Nutley soils are on flats and rises. Typically, the surface layer is very dark gray, calcareous silty clay about 7 inches thick. The subsoil is calcareous silty clay about 30 inches thick. It is dark grayish brown in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous silty clay.

The moderately well drained Overly soils are on flats. Typically, the surface soil is very dark gray silty clay loam about 10 inches thick. The subsoil is silty clay loam about 32 inches thick. It is very dark grayish brown in the upper part and dark grayish brown, mottled, and calcareous in the lower part. The upper part of the substratum is grayish brown, calcareous silty clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous clay loam.

Barnes, Cresbard, Hamerly, Parnell, and Swenoda are the principal minor soils in this association. Barnes and Swenoda soils are well drained. Barnes soils have a surface layer and subsoil of loam. They are on rises. Swenoda soils have a surface soil and subsoil of sandy loam. They are on flats and slight rises. Cresbard soils are moderately well drained and have a dense, sodic subsoil. They are on flats and in swales. Hamerly soils are somewhat poorly drained and have a layer of lime accumulation within a depth of 16 inches. They are on flats around depressions. Parnell soils are very poorly drained and are in depressions.

In most areas this association is cultivated. It is well suited to cultivated crops, range, pasture, and hay. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing range or pasture is maintaining an adequate cover of the native or introduced forage plants.

Very Deep, Sandy and Loamy Soils on Till Plains and Lake Plains

These soils formed in eolian material, glacial till, and glaciolacustrine deposits. They make up about 3 percent of the county. Most areas are cultivated. The soils are poorly suited cultivated crops but are well suited to range, pasture, and hay. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The main concerns in managing range or pasture are achieving a uniform distribution of grazing and maintaining an adequate cover of the native or introduced forage plants.

13. Swenoda-Maddock-Towner Association

Moderately coarse textured and coarse textured, level to undulating, well drained soils

This association consists of level to undulating soils on rises and flats and in swales on till plains and lake plains. A few scattered knolls and depressions are throughout most areas. Slopes generally are long and smooth. They range from 0 to 6 percent.

This association makes up about 3 percent of the county. It is about 36 percent Swenoda soils, 31 percent Maddock soils, 20 percent Towner soils, and 13 percent soils of minor extent.

The level to undulating Swenoda soils are on flats. Typically, the surface soil is about 12 inches thick. It is black. It is sandy loam in the upper part and fine sandy loam in the lower part. The subsoil is about 39 inches thick. In sequence downward, it is very dark brown fine sandy loam, very dark grayish brown fine sandy loam, dark brown clay loam, and olive brown, calcareous clay loam. The substratum to a depth of about 60 inches is light olive brown, calcareous clay loam.

The level to undulating Maddock soils are on rises and flats. Typically, the surface soil is very dark grayish brown loamy fine sand about 11 inches thick. The subsoil is dark brown loamy fine sand about 8 inches thick. The substratum to a depth of about 60 inches is fine sand. It is olive brown in the upper part, olive brown and calcareous in the next part, and grayish brown in the lower part.

The nearly level and undulating Towner soils are on flats and in swales. Typically, the surface soil is about 18 inches thick. It is black. It is loamy fine sand in the upper part and loamy sand in the lower part. The subsoil is about 23 inches thick. It is dark brown loamy sand in the upper part, brown fine sand in the next part, and olive brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous silty clay loam.

Barnes, Buse, Fossum, and Larson are the principal minor soils in this association. Barnes and Buse soils are well drained. Barnes soils have a surface layer and subsoil of loam. They are on rises. Buse soils are calcareous throughout the subsoil. They are on knolls. Fossum soils are poorly drained and are in depressions. Larson soils are somewhat poorly drained and have a dense, sodic subsoil. They are intermingled with areas of the Swenoda soils.

In most areas this association is cultivated. It is poorly suited to cultivated crops but is well suited to range, pasture, and hay. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing range are controlling soil blowing, preventing denuding, and maintaining an adequate cover of the native forage plants.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under the heading "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Wabek sandy loam, 1 to 9 percent slopes, is a phase of the Wabek series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Hamerly-Tonka complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Fram and Vallers loams, saline, 0 to 3 percent slopes, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

As a result of changes in series concepts, the location of moisture regime areas, differing soil patterns, and differences in the design of the map units, some of the soil boundaries and soil names on the detailed soil maps of this county do not match those on the maps of Burleigh, Pierce, McLean, and Wells Counties, North Dakota.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils.

Soil Descriptions

2—Marysland loam. This very deep, level, poorly drained, highly calcareous soil is in depressions and drainageways on outwash plains. Individual areas range from about 5 to more than 150 acres in size.

Typically, the surface layer is very dark gray, calcareous loam about 9 inches thick. The subsoil is gray, calcareous loam about 15 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled, and calcareous. It is gravelly sand in the upper part and very gravelly coarse sand in the lower part.

Included with this soil in mapping are small areas of Divide, Parnell, and Vallers soils. These soils make up about 5 to 20 percent of the unit. Divide soils are somewhat poorly drained. They are in swales. Parnell and Vallers soils are intermingled with areas of the Marysland soil. Parnell soils are not highly calcareous. Vallers soils have a substratum of clay loam.

Permeability is moderate in the upper part of the Marysland soil and rapid in the lower part. Runoff is very slow. Available water capacity is moderate. The seasonal high water table is within a depth of 2 feet. Organic matter content is high. Tilth is good.

Most areas are used for range, pasture, or hay. This soil is best suited to hay, range, pasture, and wildlife habitat. It is poorly suited to cultivated crops because of wetness and soil blowing. If drained, it is suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas wetness delays tillage and seeding in most years and prevents them in some years. The main concerns in managing cultivated areas are overcoming wetness and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are big bluestem, switchgrass, indiangrass, and prairie cordgrass. Creeping foxtail and reed canarygrass are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing while the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIw. The productivity index for spring wheat is 39 to 62, depending on the degree of drainage. The range site is Subirrigated. The pasture group is Wet.

6—Harriet silt loam. This very deep, level, poorly drained, sodic, strongly saline soil is on flats on terraces and flood plains. It is occasionally flooded. Individual areas range from about 5 to more than 300 acres in size.

Typically, the surface layer is very dark gray silt loam about 1 inch thick. The subsoil is about 41 inches thick. It is black silty clay loam in the upper part; grayish brown, mottled, calcareous clay loam in the next part; and gray and olive gray, mottled, calcareous silty clay loam in the lower part. The upper part of the substratum is grayish brown, mottled, calcareous loamy sand. The next part is light olive brown, mottled, calcareous fine sand. The lower part to a depth of about 60 inches is dark yellowish brown, calcareous gravelly loamy sand. In some places the subsoil does not have an accumulation of clay. In other places the surface layer and subsoil are fine sandy loam. In some areas sand and gravel are at a depth of 15 to 40 inches.

Included with this soil in mapping are small areas of Marysland, Miranda, Parnell, and Vallers soils and small areas that are barren of vegetation. Included soils make up about 5 to 20 percent of the unit. Marysland, Parnell, and Vallers soils are intermingled with areas of the Harriet soil. Marysland and Parnell soils are not saline or sodic. Marysland soils have sand and gravel at a depth of 20 to 40 inches. Marysland and Vallers soils are highly calcareous. Vallers soils do not have a dense, sodic subsoil. Miranda soils are somewhat poorly drained. They are in swales.

Permeability is slow in the Harriet soil, and runoff is very slow. The seasonal high water table is within a depth of 1 foot. Organic matter content is high.

Most areas are used for range, pasture, or hay. This soil is best suited to hay, range, pasture, and wildlife habitat. It generally is unsuited to cultivated crops because of salinity, sodicity, and wetness.

The important native forage plants are western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass, slender wheatgrass, and sweetclover are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing while the soil is wet.

This soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The wetness, the salinity, and the sodicity are critical limitations affecting survival, growth, and vigor.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland. The pasture group is Sodic and Saline.

7—Fossum loamy sand. This very deep, level, poorly drained, calcareous soil is on flats and in depressions on lake plains and outwash plains. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface soil is calcareous loamy sand about 24 inches thick. It is very dark gray in the upper part and very dark grayish brown and mottled in the lower part. The upper substratum is grayish brown, mottled, calcareous fine sand about 10 inches thick. Below this is a buried layer of very dark grayish brown, calcareous loamy fine sand about 6 inches thick. The lower substratum to a depth of about 60 inches is olive, mottled, calcareous loamy sand. In some places the soil does not have a buried layer. In other places it does not have lime throughout.

Included with this soil in mapping are small areas of Marysland, Parnell, and Southam soils. These soils make up about 5 to 20 percent of the unit. Marysland soils are highly calcareous and have sand and gravel at a depth of 20 to 40 inches. They are intermingled with areas of the Fossum soil. Parnell and Southam soils are very poorly drained. Parnell soils are in deep depressions, and Southam soils are in the deepest parts of the depressions.

Permeability is rapid in the Fossum soil, and runoff is very slow. Available water capacity is low. The seasonal high water table is at a depth of 1.0 to 2.5 feet. Organic matter content is moderate. Tilth is good.

Most areas are used for range, pasture, or hay. This soil is best suited to hay, range, pasture, and wildlife habitat. It is poorly suited to cultivated crops because of wetness and soil blowing. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas wetness usually delays or prevents tillage, seeding, or harvesting. The main concerns in managing cultivated areas are overcoming wetness and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important native forage plants are big bluestem, switchgrass, and prairie cordgrass. Creeping foxtail and reed canarygrass are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing while the soil is wet. If the range is overgrazed, soil blowing is a hazard. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVw. The productivity index for spring wheat is 31 to 47, depending on the degree of drainage. The range site is Subirrigated. The pasture group is Wet.

10—Southam silty clay loam. This very deep, level, very poorly drained, calcareous soil is in deep depressions on till plains, lake plains, and moraines. It is subject to ponding. Individual areas range from about 3 to more than 160 acres in size.

Typically, the surface soil is black, mottled, and calcareous. It is about 25 inches thick. It is silty clay loam in the upper part and silty clay in the lower part. The substratum to a depth of about 60 inches is very dark gray, calcareous silty clay. In places the surface is continuously ponded.

Included with this soil in mapping are small areas of Parnell and Vallers soils. These soils make up about 5 to 15 percent of the unit. Parnell soils have a subsoil and have carbonates below a depth of 40 inches. They are in the shallower parts of the depressions. Vallers soils have a layer of accumulated lime within a depth of 16 inches. They generally surround the depressions.

Permeability is slow in the Southam soil, and runoff is ponded. The seasonal high water table is 5 feet above to 1 foot below the surface. Available water capacity is high. Organic matter content is very high.

In most areas this soil is used for wetland wildlife habitat. It is best suited to this use. It generally is unsuited to cultivated crops, pasture, hay, and trees and shrubs because of the ponding. Locating suitable drainage outlets is difficult. As a result, few areas are drained. The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife (fig. 6). The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The land capability classification is VIIIw. The

Figure 6.—Habitat for wetland wildlife in an area of Southam silty clay loam.

productivity index for spring wheat is 0. No range site or pasture group is assigned.

11—Parnell silt loam. This very deep, level, very poorly drained soil is in deep depressions on till plains and moraines. It is subject to ponding. Individual areas range from about 3 to more than 80 acres in size.

Typically, the surface soil is black. It is about 13 inches thick. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay. In some places the soil has a subsurface layer, which is 2 to 4 inches thick. In other places the subsoil is calcareous.

Included with this soil in mapping are small areas of Southam, Tonka, and Vallers soils. These soils make up about 5 to 25 percent of the unit. Southam soils are very poorly drained and are continuously ponded. They are in the deeper parts of the depressions. Tonka soils are poorly drained and have a leached subsurface layer 5 or more inches thick. They are in the shallower parts of the depressions. Vallers soils are highly calcareous and poorly drained. They generally surround the depressions.

Permeability is slow in the Parnell soil, and runoff is ponded. The seasonal high water table is 2 feet above to 2 feet below the surface. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for range, pasture, hay, or wetland wildlife habitat (fig. 7). If drained, this soil is suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas, ponding usually delays or prevents tillage, seeding, or harvesting and crops are harvested in only about 1 or 2 years out of 10.

The important native forage plants are slough sedge and rivergrass. Where the soil is drained, reed canarygrass and creeping foxtail are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing while the soil is wet.

This soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings.

Figure 7.—An area of Parnell silt loam. This soil provides forage for livestock late in the grazing season. It also provides habitat for wetland wildlife, particularly in spring and early summer.

The land capability classification is IIIw. The productivity index for spring wheat is 23 to 75, depending on the degree of drainage. The range site is Wetland. In drained areas the pasture group is Wet.

12—Parnell-Vallers complex, 0 to 3 percent slopes. These very deep soils are on till plains. The level, very poorly drained Parnell soil is in depressions. It is subject to ponding. The level and nearly level, poorly drained, highly calcareous Vallers soil is on flats and the rim of the depressions. Individual areas range from about 10 to more than 50 acres in size. They are about 50 to 60 percent Parnell soil and 30 to 40 percent Vallers soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Parnell soil has a black surface soil about 13 inches thick. The surface soil is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay. In some places the soil has a subsurface layer, which is 2 to 4 inches thick. In other places the subsoil is calcareous.

Typically, the Vallers soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The next layer is very dark grayish brown and light gray, calcareous silt loam about 4 inches thick. The subsoil is calcareous silty clay loam about 9 inches thick. It is very dark grayish brown and grayish brown in the upper part and light brownish gray and mottled in the lower part. The substratum to a depth of about 60 inches is mottled, calcareous clay loam. It is grayish brown in the upper part and olive gray in the lower part. In some places the subsoil is clay loam. In other places the substratum is gravelly sand.

Included with these soils in mapping are small areas of Fram, Hamerly, Southam, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Fram and Hamerly soils are somewhat poorly drained. They are on the outer rims of the depressions. Southam soils are very poorly drained and are continuously ponded. They are in the deeper parts of the depressions. Tonka soils are poorly drained and have a leached subsurface layer 5 or more inches thick. They are intermingled with areas of the Vallers soil.

Permeability is slow in the Parnell soil and moderately slow in the Vallers soil. Runoff is ponded on the Parnell soil and slow on the Vallers soil. The seasonal high water table is 2.0 feet above to 2.0 feet below the surface of the Parnell soil and is at a depth of 1.0 to 2.5 feet in the Vallers soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for range, pasture, hay, or wetland wildlife habitat. If drained, these soils are suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas, ponding on the Parnell soil usually delays or prevents tillage, seeding, or harvesting and crops are harvested in only about 1 or 2 years out of 10. The hazard of soil blowing is slight on the Parnell soil and moderate on the Vallers soil. The hazard of water erosion is slight on both soils. The main concerns in managing cultivated areas are overcoming wetness and controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important native forage plants are big bluestem, switchgrass, indiangrass, slough sedge, and rivergrass. Where the Parnell soil is drained, reed canarygrass and creeping foxtail are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed during wet periods. They can be overcome by deferring grazing while the soils are wet.

The Parnell soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

If drained, these soils are suited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on these soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Vallers soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Parnell soil is IIIw, and that of the Vallers soil is IIw. The productivity index of the unit for spring wheat is 31 to 75, depending on the degree of drainage. The range site of the Parnell soil is Wetland, and that of the Vallers soil is Subirrigated. In drained areas the pasture group of the Parnell soil is Wet. The pasture group of the Vallers soil also is Wet.

15—Divide loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on outwash plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is black, calcareous loam about 8 inches thick. The next layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is about 15 inches thick. It is calcareous. It is dark gray loam in the upper part and light olive brown sandy loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous gravelly loamy sand. In some places the sand and gravel are below a depth of 40 inches. In other places the surface layer is sandy loam.

Included with this soil in mapping are small areas of Marysland and Renshaw soils. These soils make up about 5 to 20 percent of the unit. Marysland soils are highly calcareous and poorly drained. They are in depressions. Renshaw soils are somewhat excessively drained. They are on knobs and knolls.

Permeability is moderate in the upper part of the Divide soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The seasonal high water table is at a depth of 2.5 to 5.0 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. This soil is suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. Wetness delays tillage and seeding in some years. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are little bluestem, big bluestem, and switchgrass. Tall wheatgrass, slender wheatgrass, and sweetclover are among the suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 62. The range site and pasture group are Limy Subirrigated.

18—Fram and Vallers loams, saline, 0 to 3 percent slopes. These very deep, level and nearly level, somewhat poorly drained and poorly drained, highly calcareous, moderately saline soils are in drainageways and on flats on till plains. In some areas the surface has a salt crust. Any one area can consist of all Fram soil, all Vallers soil, or a combination of both soils. Individual areas range from about 5 to more than 100 acres in size.

Typically, the Fram soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 24 inches thick. It is light yellowish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous loam. It is mottled in the lower part. In some places the substratum is clay loam. In other places it is gravelly sandy loam.

Typically, the Vallers soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The next layer is very dark grayish brown and light gray, calcareous silt loam about 4 inches thick. The subsoil is calcareous silty clay loam about 9 inches thick. It is very dark grayish brown and grayish brown in the upper part and light brownish gray and mottled in the lower part. The substratum to a depth of about 60 inches is mottled, calcareous clay loam. It is grayish brown in the upper part and olive gray in the lower part. In some places the subsoil is clay loam. In other places the substratum is gravelly sand.

Included with these soils in mapping are small areas of Emrick, Parnell, Southam, Svea, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Emrick and Svea soils are moderately well drained. They are on rises. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderate in the Fram soil and moderately slow in the Vallers soil. Runoff is slow on both soils. Available water capacity is moderate. The seasonal high water table is at a depth of 2.0 to 4.0 feet in the Fram soil and is within a depth of 2.5 feet in the Vallers soil. Organic matter content is high in both soils. Tilth is good. Salts in the soils reduce the amount of water available to plants.

Most areas are used for cultivated crops, pasture, or hay. Some are used as range. These soils are best suited to hay, pasture, and range. They are poorly suited to cultivated crops because of wetness and salinity. In undrained areas wetness delays or prevents tillage and seeding in some years. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concerns in managing cultivated areas are overcoming salinity and controlling soil blowing. Avoiding summer fallow helps to control the accumulation of salts in the surface layer. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, slender wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass, alkali sacaton, and sweetclover are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems if the range is grazed during wet periods. They can be overcome by deferring grazing when the soils are wet. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing. Stock water ponds constructed in areas of these soils frequently contain salty water.

These soils are suited to only a few of the most salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water caused by the salts in the soils. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of both soils is IIIs. The productivity index of the unit for spring wheat is 31 to 38, depending on the degree of salinity and drainage. The range site of both soils is Saline Lowland. The pasture group is Saline.

19—Tonka silt loam. This very deep, level, poorly drained soil is in shallow depressions on till plains. It is subject to ponding. Individual areas range from about 5 to more than 50 acres in size.

Typically, the surface soil is black silt loam about 11 inches thick. The subsurface layer is very dark gray silt loam about 10 inches thick. The subsoil is very dark grayish brown, mottled silty clay loam about 20 inches thick. The next layer is dark grayish brown, mottled, calcareous silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is olive, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of Fram, Hamerly, and Parnell soils. These soils make up about 5 to 20 percent of the unit. Fram and Hamerly soils are highly calcareous and somewhat poorly drained. They are on the rims of depressions. Parnell soils are very poorly drained. They are in the lower parts of the depressions.

Permeability is slow in the Tonka soil, and runoff is ponded. Available water capacity is high. The seasonal high water table is 0.5 foot above to 1.0 foot below the surface. Organic matter content is high. Tilth is good.

Most areas are used for range, pasture, hay, or wetland wildlife habitat. If drained, this soil is suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas ponding delays tillage and seeding in most years and prevents them in some years. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control erosion.

The important native forage plants are slim sedge, wooly sedge, and prairie cordgrass. Creeping foxtail and reed canarygrass are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing while the soil is wet.

This soil and the ponded water provide an early season breeding site and a good supply of invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings.

The land capability classification is IIw. The productivity index for spring wheat is 41 to 83, depending on the degree of drainage. The range site is Wet Meadow. The pasture group is Wet.

23—Marysland silt loam, channeled. This very deep, level, poorly drained, highly calcareous soil is on flats on flood plains. It is occasionally flooded. The

Figure 8.—An area of Marysland silt loam, channeled.

landscape generally is dissected into small, irregularly shaped areas by meandering channels (fig. 8). Individual areas range from about 5 to more than 350 acres in size.

Typically, the surface layer is very dark gray, calcareous silt loam about 9 inches thick. The subsoil is gray, calcareous loam about 15 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled, and calcareous. It is gravelly sand in the upper part and very gravelly coarse sand in the lower part.

Included with this soil in mapping are small areas of Divide, Harriet, and Southam soils. These soils make up about 5 to 20 percent of the unit. Divide soils are somewhat poorly drained. They are on rises. Harriet soils have a dense, sodic subsoil. They are intermingled with areas of the Marysland soil. Southam soils are very poorly drained. They are in deep depressions.

Permeability is moderate in the upper part of the Marysland soil and rapid in the lower part. Runoff is very slow. Available water capacity is moderate. The seasonal high water table is within a depth of 2 feet. Organic matter content is high.

Most areas are used for range, pasture, or hay. This soil is best suited to range, pasture, hay, and wildlife habitat. It generally is unsuited to cultivated crops because most areas are isolated by channels or are irregularly shaped.

The important native forage plants are big bluestem, switchgrass, indiangrass, and prairie cordgrass. Creeping foxtail and reed canarygrass are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. They can be

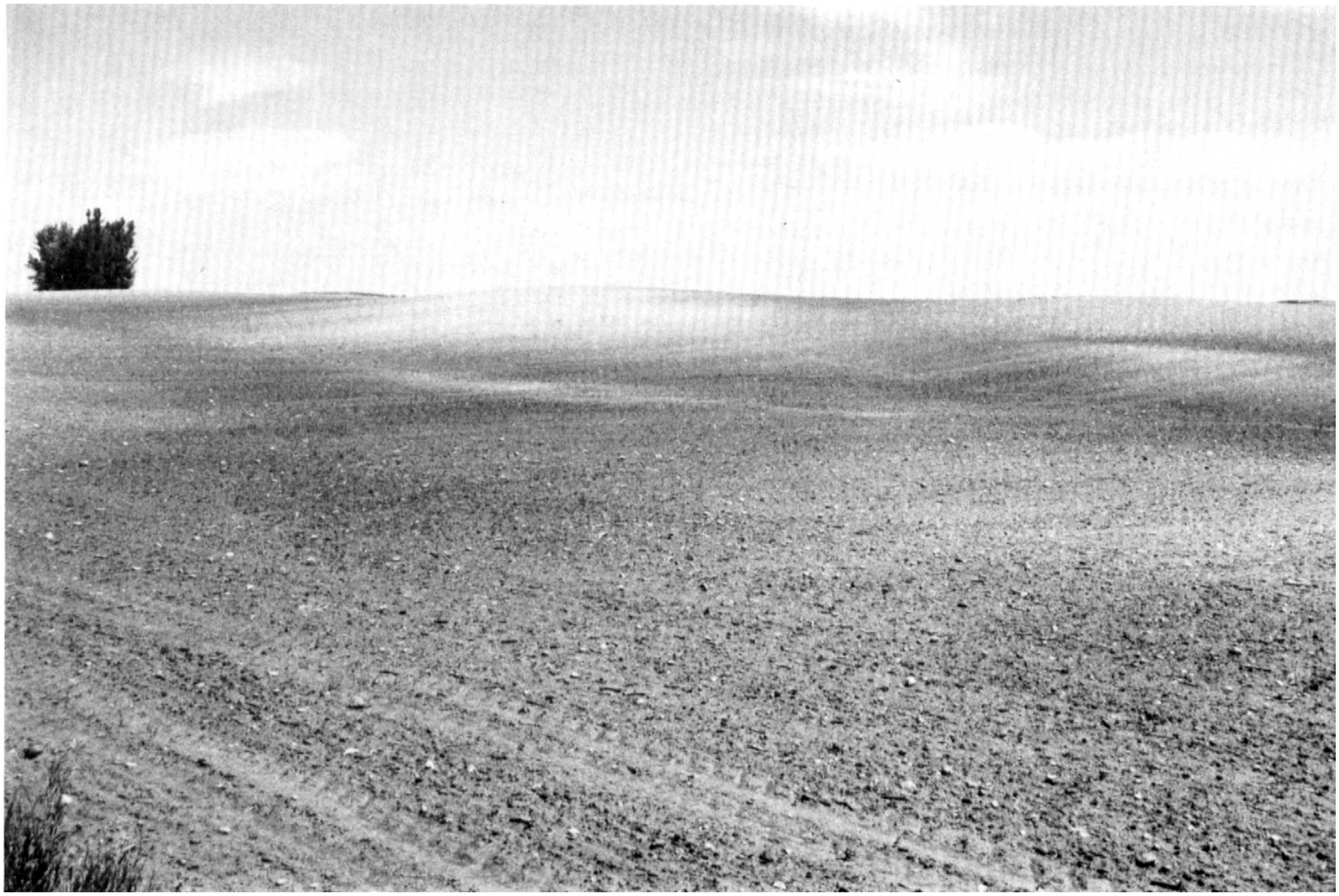

Figure 9.—An area of Barnes-Buse loams, 6 to 9 percent slopes. The Barnes soil is in the dark colored areas, and the Buse soil is in the light colored areas.

overcome by deferring grazing while the soil is wet. Maintaining an adequate cover of the important or suitable plants helps protect the soil from erosion during periods of flooding.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. Because of the isolated and irregularly shaped areas, designing the windbreaks and environmental plantings is difficult. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is VIw. The productivity index for spring wheat is 0. The range site is Subirrigated. The pasture group is Wet.

24C—Barnes-Buse loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on till plains. The Barnes soil is on side slopes, and the Buse soil is on shoulder slopes and summits (fig. 9). Individual areas range from about 5 to more than 200 acres in size. They are about 45 to 55 percent Barnes soil and 35 to 45 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the subsoil has an accumulation of clay. In other places the subsoil and substratum are sandy loam. In some areas the soil has a thin layer of gravel.

Typically, the Buse soil has a surface layer of black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In places the subsoil and substratum are sandy loam.

Included with these soils in mapping are small areas of Emrick, Parnell, Southam, Svea, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Emrick and Svea soils are dark to a depth of more than 16 inches. They are in swales. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is rapid. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. These soils are suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is severe on both soils. The main concern in managing cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are little bluestem, green needlegrass, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, green needlegrass, and alfalfa are among the suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Buse soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 52. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland. The pasture group of the Barnes soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

26B—Barnes-Cresbard loams, 1 to 6 percent slopes. These very deep, nearly level and undulating soils are on till plains. The well drained Barnes soil is on rises. The moderately well drained, sodic Cresbard soil is in swales. Individual areas range from about 10 to more than 200 acres in size. They are about 40 to 60 percent Barnes soil and 30 to 40 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Cresbard soil has a surface layer of very dark gray loam about 6 inches thick. The next layer is very dark grayish brown and dark grayish brown clay loam about 7 inches thick. The subsoil is clay loam about 31 inches thick. It is brown in the upper part, dark grayish brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous clay loam. In places the soil has less clay.

Included with these soils in mapping are small areas of Buse, Cavour, Hamerly, Parnell, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Buse soils have a calcareous surface layer and subsoil. They are on knobs and knolls. Cavour soils have columnar structure in the subsoil. They are intermingled with areas of the Cresbard soil. Hamerly soils are highly calcareous and somewhat poorly drained. They are on the rims of depressions. Parnell soils are very poorly drained. They are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Barnes soil and slow in the Cresbard soil. Runoff is medium on both soils. Available water capacity is high. The seasonal high water table is at a depth of 4 to 6 feet in the Cresbard soil. Organic matter content is high in the Barnes soil and moderate in the Cresbard soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and blue grama. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are among the suitable hay and pasture plants. Water erosion is a hazard, especially if the range is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cresbard soil is suited to many of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Individual trees and shrubs growing on the Cresbard soil vary in height, density, and vigor, which are affected by restricted root development in the dense, sodic subsoil and the reduced amount of available water caused by the salts in the soil.

The land capability classification of the Barnes soil is IIe, and that of the Cresbard soil is IIIe. The productivity index of the unit for spring wheat is 74. The range site of the Barnes soil is Silty, and that of the Cresbard soil is Clayey. The pasture group of the Barnes soil is Loamy and Silty, and that of the Cresbard soil is Clayey Subsoil.

30—Svea-Barnes loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on till plains. The moderately well drained Svea soil is in swales. The well drained Barnes soil is on rises. Individual areas range from about 10 to more than 200 acres in size. They are about 50 to 60 percent Svea soil and 30 to 40 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 39 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and dark grayish brown and calcareous in the lower part. Below this to a depth of about 60 inches is dark grayish brown, calcareous loam. In places the subsoil and substratum are sandy loam.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In places the subsoil and substratum are loam.

Included with these soils in mapping are small areas of Buse, Cresbard, Parnell, Southam, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Buse soils have a calcareous surface layer and subsoil. They are on knobs and knolls. Cresbard soils have a dense, sodic subsoil. They are intermingled with areas of the Svea soil. Parnell and Southam soils are very poorly drained. They are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and big bluestem. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, switchgrass, and alfalfa are among the suitable hay and pasture plants. No major problems affect the use of these soils as range or pasture.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Barnes soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 87. The range site of the Svea soil is Overflow, and that of the Barnes soil is Silty. The pasture group of the Svea soil is Overflow and Run-on, and that of the Barnes soil is Loamy and Silty.

30B—Barnes-Svea loams, 3 to 6 percent slopes. These very deep, undulating soils are on till plains. The well drained Barnes soil is on rises. The moderately well drained Svea soil is in swales. Individual areas range from about 10 to more than 1,000 acres in size. They are about 50 to 60 percent Barnes soil and 30 to 40 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 39 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and dark grayish brown and calcareous in the lower part. Below this to a depth of about 60 inches is dark grayish brown, calcareous loam. In places the subsoil and substratum are sandy loam.

Included with these soils in mapping are small areas of Buse, Hamerly, Parnell, Renshaw, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Buse soils have a calcareous surface layer and subsoil. They are on knobs and knolls. Hamerly soils are highly calcareous and somewhat poorly drained. They are in swales. Parnell soils are very poorly drained. They are in depressions. Renshaw soils are somewhat excessively drained. They are intermingled with areas of the Barnes soil. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is medium. Available water capacity is high. The seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, switchgrass, and alfalfa are among the suitable hay and pasture plants. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to all of the climatically adapted species. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 74. The range site of both soils is Silty. The pasture group is Loamy and Silty.

32C—Barnes-Buse-Parnell complex, 0 to 9 percent slopes. These very deep soils are on till plains and moraines. The well drained, nearly level to gently rolling Barnes soil is on side slopes. The well drained, undulating and gently rolling Buse soil is on shoulder slopes, knobs, and knolls. The very poorly drained, level Parnell soil is in depressions. It is subject to ponding. Individual areas range from about 20 to more than 200 acres in size. They are about 40 to 50 percent Barnes soil, 30 to 40 percent Buse soil, and 10 to 30 percent Parnell soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the subsoil and substratum are sandy loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a surface layer of black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In other places the subsoil and substratum are sandy loam.

Typically, the Parnell soil has a black surface soil about 13 inches thick. The surface soil is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay. In some places the soil has a subsurface layer, which is 2 to 4 inches thick. In other places the subsoil is calcareous.

Included with these soils in mapping are small areas of Hamerly, Sioux, Southam, Tonka, and Vallers soils. These included soils make up about 5 to 20 percent of the unit. Hamerly and Vallers soils are highly calcareous. They surround depressions. Sioux soils are excessively drained. They are intermingled with areas of the Buse soil. Southam and Tonka soils are in depressions. Southam soils are very poorly drained and are continuously ponded. Tonka soils are poorly drained.

Permeability is moderately slow in the Barnes and Buse soils and slow in the Parnell soil. Runoff is rapid on the Barnes and Buse soils and ponded on the Parnell soil. Available water capacity is high in all three soils. The seasonal high water table is 2 feet above to 2 feet below the surface of the Parnell soil. Organic matter content is high in the Barnes and Parnell soils and moderately low in the Buse soil. Tilth is good in all three soils.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. The Barnes and Buse soils are suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. If drained, the Parnell soil is well suited to those crops. Locating suitable drainage outlets is difficult on the Parnell soil. As a result, few areas are drained. In undrained areas, ponding usually delays or prevents seeding or harvesting and crops are harvested in only 1 or 2 years out of 10. The hazard of soil blowing is moderate on the Buse soil and slight on the Barnes and Parnell soils. The hazard of water erosion is severe on the Barnes and Buse soils and slight on the Parnell soil. The main concerns in managing cultivated areas are overcoming wetness on the Parnell soil and controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, little bluestem, and needleandthread on the Barnes and Buse soils and slough sedge and rivergrass on the Parnell soil. Intermediate wheatgrass, smooth bromegrass, little bluestem, western wheatgrass, and alfalfa are among the suitable hay and pasture plants on the Barnes and Buse soils. Where the Parnell soil is drained, reed canarygrass and creeping foxtail are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems if the range or pasture is grazed when the Parnell soil is wet. They can be overcome by deferring grazing when the soil is wet. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Parnell soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. If drained, the Parnell soil is suited to all of the climatically adapted species. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Parnell soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Buse soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIIe, that of the Buse soil is IVe, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 45 to 59, depending on the degree of drainage in areas of the Parnell soil. The range site of the Barnes soil is Silty, that of the Buse soil is Thin Upland, and that of the Parnell soil is Wetland. The pasture group of the Barnes soil is Loamy and Silty, that of the Buse soil is Thin Upland, and that of drained areas of the Parnell soil is Wet.

32F—Barnes-Buse-Parnell complex, 0 to 35 percent slopes. These very deep soils are on moraines. The well drained, rolling and hilly Barnes soil is on side slopes. The well drained, rolling to steep Buse soil is on shoulder slopes, ridges, knobs, and knolls. The very poorly drained, level Parnell soil is in depressions. It is subject to ponding. Stones and boulders are on some of the shoulder slopes and convex side slopes and on the rims of some depressions. Individual areas range from about 20 to more than 1,000 acres in size. They are about 40 to 50 percent Barnes soil, 30 to 40 percent Buse soil, and 10 to 30 percent Parnell soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the subsoil and substratum are sandy loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a surface layer of black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In other places the subsoil and substratum are sandy loam.

Typically, the Parnell soil has a black surface soil about 13 inches thick. The surface soil is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay. In some places the soil has a subsurface layer, which is 2 to 4 inches thick. In other places the subsoil is calcareous.

Included with these soils in mapping are small areas of Hamerly, Sioux, and Vallers soils. These included soils make up about 5 to 15 percent of the unit. Hamerly and Vallers soils are calcareous throughout. Hamerly soils surround depressions. Vallers soils are in the depressions. Sioux soils are excessively drained. They are on knobs and ridgetops.

Permeability is moderately slow in the Barnes and Buse soils and slow in the Parnell soil. Runoff is rapid on the Barnes and Buse soils and ponded on the Parnell soil. Available water capacity is high in all three soils. The seasonal high water table is 2 feet above to 2 feet below the surface of the Parnell soil. Organic matter content is high in the Barnes and Parnell soils and moderately low in the Buse soil.

In most areas these soils are used as range or wildlife habitat. They are best suited to these uses. They are generally unsuited to wheat, oats, and barley and to grasses and legumes for pasture and hay because of the slope and the hazard of erosion on the Buse and Barnes soils.

The important native forage plants are western wheatgrass, green needlegrass, little bluestem, and needleandthread on the Barnes and Buse soils and slough sedge and rivergrass on the Parnell soil. Compaction, trampling, and root shearing are problems if the range is grazed when the Parnell soil is wet. They can be overcome by deferring grazing when the soil is wet. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion and prevent denuding.

The Parnell soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The Barnes and Buse soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. If drained, the Parnell soil is suited to all the climatically adapted species. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Parnell soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings.

The land capability classification of the Barnes soil is VIe, that of the Buse soil is VIIe, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 0. The range site of the Barnes soil is Silty, that of the Buse soil is Thin Upland, and that of the Parnell soil is Wetland. No pasture group is assigned.

35B—Overly silty clay loam, 0 to 6 percent slopes. This very deep, level to undulating, moderately well drained soil is on flats and rises on lake plains. Individual areas range from about 5 to more than 200 acres in size.

Typically, the surface soil is very dark gray silty clay loam about 10 inches thick. The subsoil is silty clay loam about 32 inches thick. It is very dark grayish brown in the upper part and dark grayish brown, mottled, and calcareous in the lower part. The substratum to a depth of about 60 inches is mottled and calcareous. It is grayish brown silty clay loam in the upper part and olive brown clay loam in the lower part. In some places the dark color of the surface layer and subsoil extends to a depth of only 8 to 16 inches.

Included with this soil in mapping are small areas of Barnes and Parnell soils. These soils make up about 5 to 20 percent of the unit. Barnes soils are well drained and are loam and clay loam throughout. They are on side slopes. Parnell soils are very poorly drained. They are in depressions. Also included are small areas of a highly calcareous, somewhat poorly drained soil in swales.

Permeability is moderately slow in the Overly soil, and runoff is medium. Available water capacity is high. The seasonal high water table is at a depth of 4 to 6 feet. Organic matter content is high. Tilth is fair.

Most areas are used for cultivated crops. This soil is well suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, switchgrass, and alfalfa are among the suitable hay and pasture plants. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification is IIe. The productivity index for spring wheat is 85. The range site is Silty. The pasture group is Loamy and Silty.

36D—Buse-Barnes loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on moraines dissected by drainageways. The Buse soil is on ridges and shoulder slopes. The Barnes soil is on side slopes and summits. Stones or boulders are on some ridges, shoulder slopes, and side slopes. Individual areas range from about 10 to more than 200 acres in size. They are about 45 to 60 percent Buse soil and 25 to 40 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a surface layer of black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the surface layer is very dark brown. In other places the subsoil and substratum are sandy loam.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In places the subsoil and substratum are sandy loam.

Included with these soils in mapping are small areas of Emrick, Parnell, Sioux, Southam, Svea, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Emrick and Svea soils are dark to a depth of more than 16 inches. They are in swales. Parnell soils are very poorly drained. They are in depressions. Sioux soils have a substratum of very gravelly sand. They are on ridges. Southam soils are very poorly drained and are continuously ponded. They are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Buse and Barnes soils. Runoff is rapid. Available water capacity is high. Organic matter content is moderately low in the Buse soil and high in the Barnes soil.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. These soils are generally unsuited to cultivated crops because of the slope and the hazard of erosion. They are best suited to grasses and legumes for range, pasture, and hay. The main concerns in managing cultivated areas are maintaining productivity and controlling erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates reduce the hazard of erosion but do not adequately control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Establishing a cover of grasses in cultivated areas helps to maintain productivity and control erosion.

In areas where these soils are used as range, the important forage plants are little bluestem, green needlegrass, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, prairie sandreed, and alfalfa are among the suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Buse soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Barnes soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of the Buse soil is VIe, and that of the Barnes soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty. The pasture group of the Buse soil is Thin Upland, and that of the Barnes soil is Loamy and Silty.

36F—Buse-Barnes loams, 15 to 35 percent slopes. These very deep, well drained soils are on moraines dissected by drainageways. The hilly and steep Buse soil is on ridges and shoulder slopes. The hilly Barnes soil is on side slopes and summits. Stones or boulders are on some ridges, shoulder slopes, and side slopes. Individual areas range from about 10 to more than 500 acres in size. They are about 45 to 55 percent Buse soil and 30 to 40 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a surface layer of black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the surface layer is very dark brown. In other places the subsoil and substratum are sandy loam.

Typically, the Barnes soil has a surface layer of black loam about 5 inches thick. The subsoil is clay loam about 18 inches thick. It is very dark brown in the upper part and dark grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In places the subsoil and substratum are sandy loam.

Included with these soils in mapping are small areas of Emrick, Parnell, Sioux, and Svea soils. These included soils make up about 5 to 20 percent of the unit. Emrick and Svea soils are dark to a depth of more than 16 inches. They are in swales. Parnell soils are very poorly drained. They are in depressions. Sioux soils have a substratum of very gravelly sand. They are on ridges.

Permeability is moderately slow in the Buse and Barnes soils. Runoff is very rapid. Available water capacity is high. Organic matter content is moderately low in the Buse soil and high in the Barnes soil.

Most areas are used as range. Some are used for cultivated crops, pasture, or hay. These soils generally are unsuited to cultivated crops and to grasses and legumes for pasture and hay because of the slope and the hazard of erosion. They are best suited to range. Establishing a cover of grasses in cultivated areas can help to control soil blowing and water erosion.

The important native forage plants are little bluestem, green needlegrass, and western wheatgrass. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Buse soil is VIIe, and that of the Barnes soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty. No pasture group is assigned.

37B—Cresbard-Cavour loams, 0 to 6 percent slopes. These very deep, level to undulating, moderately well drained, sodic soils are on till plains. The Cresbard soil is on flats and rises. The Cavour soil is in swales. Individual areas range from about 5 to more than 150 acres in size. They are about 40 to 55 percent Cresbard soil and 25 to 40 percent Cavour soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cresbard soil has a surface layer of very dark gray loam about 6 inches thick. The next layer is very dark grayish brown and dark grayish brown clay loam about 7 inches thick. The subsoil is clay loam about 31 inches thick. It is brown in the upper part, dark grayish brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In places the soil has less clay.

Typically, the Cavour soil has a surface layer of black loam about 7 inches thick. The subsurface layer is very dark gray loam about 1 inch thick. The subsoil is about 38 inches thick. In sequence downward, it is black silty clay; black, calcareous silty clay; dark gray, calcareous silty clay loam; and grayish brown, mottled, calcareous silty clay. The substratum to a depth of about 60 inches is mottled, calcareous loam. It is grayish brown in the upper part and dark grayish brown in the lower part. In places the soil has less clay.

Included with these soils in mapping are small areas of Barnes, Buse, Hamerly, Harriet, Miranda, and Parnell soils. These included soils make up about 5 to 20 percent of the unit. Barnes soils do not have a dense, sodic subsoil and are well drained. They are intermingled with areas of the Cresbard soil. Buse soils have a calcareous surface layer and subsoil. They are on knobs and knolls. Hamerly soils are highly calcareous and somewhat poorly drained. They are on the rims of depressions. Harriet soils are poorly drained. They are on flats. Miranda soils are somewhat poorly drained. They are intermingled with areas of the Cavour soil. Parnell soils are very poorly drained. They are in deep depressions.

Permeability is slow in the Cresbard soil and very slow in the Cavour soil. Runoff is medium on both soils. Available water capacity is high in the Cresbard soil and moderate in the Cavour soil. The seasonal high water table is at a depth of 4 to 6 feet in both soils. Organic matter content is moderate. Tilth is fair.

Most areas are used for cultivated crops. Some are used for range, pasture, or hay. These soils are somewhat poorly suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay because of a dense subsoil and a high content of sodium. The dense, sodic subsoil restricts root penetration. The hazard of soil blowing is slight on both soils, and the hazard of water erosion is moderate. The main concerns in managing cultivated areas are controlling water erosion and maintaining productivity. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates help to control water erosion and maintain productivity. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, and green needlegrass. Intermediate wheatgrass, tall wheatgrass, smooth bromegrass, and alfalfa are among the suitable hay and pasture plants. The dense, sodic subsoil restricts root penetration, and the salts reduce the amount of water available to plants, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding.

The Cresbard soil is suited to many of the trees and shrubs grown as windbreaks and environmental plantings. The Cavour soil is suited to only a few of the drought- and salt-tolerant species. Individual trees and shrubs growing on these soils vary in height, density, and vigor, which are affected by restricted root development in the dense, sodic subsoil and the reduced amount of available water caused by the salts. Irrigation helps to ensure survival of the seedlings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of the Cresbard soil is IIIe, and that of the Cavour soil is IVs. The productivity index of the unit for spring wheat is 59. The range site of the Cresbard soil is Clayey, and that of the Cavour soil is Claypan. The pasture group of the Cresbard soil is Clayey Subsoil, and that of the Cavour soil is Claypan.

38—Miranda loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, sodic, moderately saline soil is on flats on till plains. Individual areas range from about 5 to more than 250 acres in size.

Typically, the surface layer is very dark gray loam about 1 inch thick. The subsoil is clay loam about 45 inches thick. In sequence downward, it is black; very dark gray; dark grayish brown, mottled, and calcareous; and grayish brown, mottled, and calcareous. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is sandy loam in the upper part and loam in the lower part.

Included with this soil in mapping are small areas of Cavour, Cresbard, Hamerly, Harriet, and Larson soils. These soils make up about 5 to 20 percent of the unit. Cavour and Cresbard soils are moderately well drained and have more clay in the subsoil than the Miranda soil. They are on rises. Hamerly soils are highly calcareous. They are on the rims of depressions. Harriet soils are poorly drained. They are in the depressions. Larson soils have salts below a depth of 16 inches. They are in swales.

Permeability is very slow on the Miranda soil, and runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 2 to 4 feet. Organic matter content is moderately low.

Most areas are used for range, pasture, or hay. This soil is best suited to range and wildlife habitat. It generally is unsuited to cultivated crops and to trees and shrubs. It is poorly suited to hay and pasture. The major limitations are the content of salts, a dense subsoil, and a high content of sodium.

The important native forage plants are western wheatgrass and inland saltgrass. Slender wheatgrass, western wheatgrass, and alfalfa are among the suitable hay and pasture plants. The dense, sodic subsoil, which restricts root penetration, and the salts, which reduce the amount of available water, are limitations, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site and pasture group are Thin Claypan.

40F—Orthents, loamy, 1 to 75 percent slopes. These very deep, nearly level to very steep, well drained soils are along the McClusky Canal and in other disturbed areas. Individual areas range from about 15 to more than 250 acres in size.

The surface layer is very dark grayish brown, calcareous, compacted loam about 3 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, calcareous, compacted loam.

Permeability is moderately slow, and runoff is slow to very rapid. Available water capacity is high. Organic matter content is low.

Most areas are used for hay or wildlife habitat. Some are used for pasture. Because of the slope and a very severe hazard of water erosion, these soils generally are unsuited to cultivated crops. In areas where the soils are used for hay or pasture, the suitable plants include smooth bromegrass, intermediate wheatgrass, little bluestem, and alfalfa. Water erosion, soil blowing, and soil slumping are the main management concerns. Maintaining an adequate cover of the suitable forage plants helps to control water erosion and prevent slumping. In some areas the use of machinery is difficult because of the slope. Gullies can form along cattle trails if the soils are used for grazing.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification is VIIe. The productivity index for spring wheat is 0. The range site and pasture group are Thin Upland.

41C—Towner-Maddock-Buse complex, 1 to 9 percent slopes. These very deep, well drained soils are on mantled till plains. The nearly level and undulating Towner soil is on side slopes and in swales. The nearly level and undulating Maddock soil is on side slopes. The undulating and gently rolling Buse soil is on shoulder slopes and summits. Individual areas range from about 5 to more than 200 acres in size. They are about 35 to 45 percent Towner soil, 25 to 40 percent Maddock soil, and 10 to 25 percent Buse soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Towner soil has a black surface soil about 18 inches thick. The surface soil is loamy fine sand in the upper part and loamy sand in the lower part. The subsoil is about 23 inches thick. It is dark brown loamy sand in the upper part, brown fine sand in the next part, and olive brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous silty clay loam. In places the dark color of the surface layer extends to a depth of only 8 to 16 inches.

Typically, the Maddock soil has a surface soil of very dark grayish brown loamy fine sand about 11 inches thick. The subsoil is dark brown loamy fine sand about 8 inches thick. The substratum to a depth of about 60 inches is fine sand. It is olive brown in the upper part, olive brown and calcareous in the next part, and grayish brown in the lower part. In some places the surface soil is fine sand or sandy loam. In other places the soil is mottled at a depth of 20 to 40 inches.

Typically, the Buse soil has a surface layer of black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the dark color of the surface layer extends to a depth of 8 to 16 inches. In other places the subsoil and substratum are sandy loam.

Included with these soils in mapping are small areas of Larson, Sioux, and Swenoda soils. These included soils make up about 5 to 20 percent of the unit. Larson soils are somewhat poorly drained and have a dense, sodic subsoil. They are in swales. Sioux soils are excessively drained. They are intermingled with areas of the Buse soil. Swenoda soils have a surface soil of sandy loam. They are intermingled with areas of the Towner soil.

Permeability is moderately rapid in the upper part of the Towner soil and moderately slow in the lower part. It is rapid in the Maddock soil and moderately slow in the Buse soil. Runoff is slow on the Towner and Maddock soils and rapid on the Buse soil. Available water capacity is moderate in the Towner soil, low in the Maddock soil, and high in the Buse soil. Organic matter content is moderately low in all three soils.

Most areas are used for cultivated crops or hay. Some are used as range or pasture. Because the Towner and Maddock soils are somewhat droughty, this unit is very poorly suited to small grain, flax, and sunflowers. It is best suited to rye and winter wheat and to range and pasture. Rye and winter wheat protect the surface against soil blowing in fall, winter, and spring and make the best use of the moisture available early in the growing season. The hazard of soil blowing is severe on the Towner and Maddock soils and moderate on the Buse soil. The hazard of water erosion is moderate on the Towner and Maddock soils and severe on the Buse soil. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, annual buffer strips, such as flax strips, and field windbreaks help to prevent excessive soil loss. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Little benefit is derived from fallowing because of the limited available water capacity. Also, fallowing increases the susceptibility to soil blowing.

In areas where these soils are used as range, the important forage plants are prairie sandreed, needleandthread, and blue grama. Intermediate wheatgrass, pubescent wheatgrass, green needlegrass, switchgrass, and alfalfa are among the suitable hay and pasture plants. Soil blowing, water erosion, and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soils, control soil blowing and water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Towner and Maddock soils are suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. These soils are somewhat droughty, and moisture stress commonly affects the trees and shrubs, particularly during the establishment period. Little benefit is derived from fallowing during the season prior to planting because of the limited available water capacity. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the three soils is IVe. The productivity index of the unit for spring wheat is 45. The range site and pasture group of the Towner and Maddock soils are Sands, and those of the Buse soil are Thin Upland.

41E—Towner-Maddock-Buse complex, 9 to 25 percent slopes. These very deep, well drained soils are on mantled till plains. The rolling Towner soil and the rolling and hilly Maddock soil are on side slopes. The rolling and hilly Buse soil is on shoulder slopes and summits. Individual areas range from about 10 to more than 150 acres in size. They are about 35 to 45 percent Towner soil, 30 to 40 percent Maddock soil, and 20 to 30 percent Buse soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Towner soil has a black surface soil about 18 inches thick. The surface soil is loamy fine sand in the upper part and loamy sand in the lower part. The subsoil is about 23 inches thick. It is dark brown loamy sand in the upper part, brown fine sand in the next part, and olive brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous silty clay loam. In some places the surface layer is sandy loam. In other places the dark color of the surface layer extends to a depth of only 8 to 16 inches.

Typically, the Maddock soil has a surface soil of very dark grayish brown loamy fine sand about 11 inches thick. The subsoil is dark brown loamy fine sand about 8 inches thick. The substratum to a depth of about 60 inches is fine sand. It is olive brown in the upper part, olive brown and calcareous in the next part, and grayish brown in the lower part. In some places the surface soil is fine sand or sandy loam. In other places the soil is mottled at a depth of 20 to 40 inches.

Typically, the Buse soil has a surface layer of black loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous clay loam. In some places the dark color of the surface layer extends to a depth of 8 to 16 inches. In other places the subsoil and substratum are sandy loam.

Included with these soils in mapping are small areas of Sioux and Swenoda soils. These included soils make up about 5 to 15 percent of the unit. Sioux soils have a substratum of very gravelly sand. They are on ridges. Swenoda soils have a surface layer of sandy loam. They are intermingled with areas of the Towner soil.

Permeability is moderately rapid in the upper part of the Towner soil and moderately slow in the lower part. It is rapid in the Maddock soil and moderately slow in the Buse soil. Runoff is slow on the Towner soil, medium on the Maddock soil, and very rapid on the Buse soil. Available water capacity is moderate in the Towner soil, low in the Maddock soil, and high in the Buse soil. Organic matter content is moderately low in all three soils.

Most areas are used as range. These soils generally are unsuited to cultivated crops and to grasses and legumes for pasture and hay because of the slope and the hazard of erosion.

The important native forage plants are prairie sandreed, needleandthread, little bluestem, and blue grama. Soil blowing, water erosion, and drought are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants at a height that traps snow helps to store water in the soils, control soil blowing and water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purpose or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Towner soil is VIe, and that of the Maddock and Buse soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Towner and Maddock soils is Sands, and that of the Buse soil is Thin Upland. No pasture group is assigned.

42B—Towner loamy fine sand, 0 to 6 percent slopes. This very deep, level and undulating, well drained soil is on flats and rises on mantled till plains and lake plains. Individual areas range from about 10 to more than 500 acres in size.

Typically, the surface soil is black. It is about 18 inches thick. It is loamy fine sand in the upper part and loamy sand in the lower part. The subsoil is about 23 inches thick. It is dark brown loamy sand in the upper part, brown fine sand in the next part, and olive brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous silty clay loam. In some places the surface layer is sandy loam. In other places the dark color of the surface layer extends to a depth of only 8 to 16 inches.

Included with this soil in mapping are small areas of Fossum, Maddock, and Swenoda soils. These soils make up about 5 to 20 percent of the unit. Fossum soils are poorly drained. They are in depressions. Maddock and Swenoda soils are intermingled with areas of the Towner soil. Maddock soils have a subsoil and substratum of fine sand. Swenoda soils have a surface layer of sandy loam.

Permeability is moderately rapid in the upper part of the Towner soil and moderately slow in the lower part. Runoff is very slow. Available water capacity is moderate. Organic matter content is moderately low. Tilth is good.

Most areas are used for cultivated crops or hay. Some are used as range or pasture. This soil is suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazard of soil blowing is severe, and the hazard of water erosion is slight. In most years crops are affected by moisture stress because of the moderate available water capacity. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Little benefit is derived from fallowing because of the limited available water capacity. Also, fallowing increases the susceptibility to soil blowing.

In areas where this soil is used as range, the important forage plants are needleandthread, prairie sandreed, and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are among the suitable hay and pasture plants. Soil blowing, water erosion, and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control soil blowing and water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Little benefit is derived from fallowing during the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 51. The range site and pasture group are Sands.

44B—Swenoda sandy loam, 0 to 6 percent slopes. This very deep, level and undulating, well drained soil is on flats and rises on mantled till plains and lake plains. Individual areas range from about 10 to more than 200 acres in size.

Typically, the surface soil is black. It is about 12 inches thick. It is sandy loam in the upper part and fine sandy loam in the lower part. The subsoil is about 39 inches thick. In sequence downward, it is very dark brown fine sandy loam, very dark grayish brown fine sandy loam, dark brown clay loam, and olive brown, calcareous clay loam. The substratum to a depth of about 60 inches is light olive brown, calcareous clay loam. In some places the surface soil and subsoil are loam. In other places the dark color of the surface soil and subsoil extends to a depth of only 8 to 16 inches. In a few places the soil is sandy loam throughout.

Included with this soil in mapping are small areas of Fram, Heimdal, and Parnell soils. These soils make up about 5 to 20 percent of the unit. Fram soils are highly calcareous and somewhat poorly drained. They are on flats. Heimdal soils have a surface layer of loam. They are on side slopes. Parnell soils are very poorly drained. They are in depressions.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. Runoff is medium. Available water capacity and organic matter content is are high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is severe, and the hazard of water erosion is moderate. The main concern in managing cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are needleandthread, prairie sandreed, and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and alfalfa are among the suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation helps to ensure survival of the seedlings. Little benefit is derived from fallowing during the season prior to planting because of the limited available water capacity in the upper part of the profile. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 73. The range site and pasture group are Sandy.

45B—Cathay-Emrick loams, 0 to 6 percent slopes. These very deep, level to undulating, moderately well drained soils are on till plains. The sodic Cathay soil is in swales. The Emrick soil is on rises. Individual areas range from about 10 to more than 1,000 acres in size. They are about 45 to 55 percent Cathay soil and 35 to 45 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cathay soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 39 inches thick. In sequence downward, it is very dark grayish brown, dark brown, light olive brown and calcareous, and light yellowish brown and calcareous. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In places the subsoil and substratum are clay loam.

Typically, the Emrick soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 36 inches thick. It is very dark grayish brown in the upper part, grayish brown and calcareous in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some places the subsoil and substratum are clay loam. In other places the dark color of the surface layer extends to a depth of only 7 to 16 inches.

Included with these soils in mapping are small areas of Fram, Larson, Parnell, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Fram soils are highly calcareous and somewhat poorly drained. They are in swales. Larson soils have a subsoil of dense clay loam and are somewhat poorly drained. They are in swales. Parnell soils are very poorly drained. They are in depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Cathay soil and moderate in the Emrick soil. Runoff is medium on both soils. Available water capacity is high. The seasonal high water table is at a depth of 3 to 5 feet in the Cathay soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight on both soils, and the hazard of water erosion is moderate. Soil blowing occurs during some storms. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are among the suitable hay and pasture plants. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Cathay soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. Individual trees and shrubs growing on the Cathay soil vary in height, density, and vigor, which are affected by restricted root development in the dense, sodic subsoil and the reduced amount of available water caused by the content of salts. The Emrick soil has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of the Cathay soil is IIIe, and that of the Emrick soil is IIe. The productivity index of the unit for spring wheat is 74. The range site of the Cathay soil is Clayey, and that of the Emrick soil is Silty. The pasture group of the Cathay soil is Clayey Subsoil, and that of the Emrick soil is Loamy and Silty.

46—Larson-Cathay loams, 0 to 3 percent slopes. These very deep, level and nearly level, sodic soils are on till plains. The somewhat poorly drained Larson soil is in swales. The moderately well drained Cathay soil is on flats and rises. Individual areas range from about 10 to more than 150 acres in size. They are about 40 to 55 percent Larson soil and 25 to 35 percent Cathay soil. The two soils occur as areas so intricately mixed or small that mapping them separately is not practical.

Typically, the Larson soil has a surface layer of black loam about 8 inches thick. The subsurface layer is dark gray fine sandy loam about 3 inches thick. The subsoil extends to a depth of about 60 inches. In sequence downward, it is very dark grayish brown clay loam; dark grayish brown, calcareous clay loam; olive brown, calcareous loam; and olive brown, calcareous clay loam.

Typically, the Cathay soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 39 inches thick. In sequence downward, it is very dark grayish brown, dark brown, light olive brown and calcareous, and light yellowish brown and calcareous. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In places the subsoil and substratum are clay loam.

Included with these soils in mapping are small areas of Emrick, Fram, Harriet, Heimdal, Miranda, Parnell, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Emrick soils do not have a dense subsoil. They are in swales. Fram soils are highly calcareous. They are on the rims of depressions. Harriet soils are poorly drained. They are on flats. Heimdal soils are well drained. They are on rises. Miranda soils have salts within 16 inches of the surface. They are intermingled with areas of the Larson soil. Parnell soils are very poorly drained. They are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is slow in the Larson soil and moderately slow in the Cathay soil. Runoff is slow on both soils. Available water capacity is moderate in the Larson soil and high in the Cathay soil. The seasonal high water table is at a depth of 3 to 6 feet in the Larson soil and 3 to 5 feet in the Cathay soil. Organic matter content is high in both soils. Tilth is fair.

Most areas are used for cultivated crops. Some are used for range, pasture, or hay. These soils are poorly suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay because of the dense subsoil, the content of salts, and a high content of sodium. The hazards of soil blowing and water erosion are slight on both soils. The dense, sodic subsoil restricts root penetration. Growing deep-rooted legumes, such as alfalfa, improves the penetration of roots in the dense subsoil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, and green needlegrass. Intermediate wheatgrass, tall wheatgrass, Russian wildrye, and alfalfa are among the suitable hay and pasture plants. The dense, sodic subsoil, which restricts root penetration, and the salts, which reduce the amount of available water, are limitations, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding.

The Larson soil is suited to only a few of the drought- and salt-tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cathay soil is suited to many of the climatically adapted species. Individual trees and shrubs growing on these soils vary in height, density, and vigor, which are affected by restricted root development in the dense, sodic subsoil and the reduced amount of available water caused by the salts in the soils. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Irrigation helps to ensure survival of the seedlings.

The land capability classification of the Larson soil is IVs, and that of Cathay soil is IIIs. The productivity index of the unit for spring wheat is 48. The range site of the Larson soil is Claypan, and that of the Cathay soil is Clayey. The pasture group of the Larson soil is Claypan, and that of the Cathay soil is Clayey Subsoil.

53B—Renshaw loam, 0 to 6 percent slopes. This very deep, level to undulating, somewhat excessively drained soil is on flats and rises on outwash plains. Individual areas range from about 10 to more than 250 acres in size.

Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 9 inches thick. It is very dark grayish brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is calcareous very gravelly loamy sand. It is dark brown in the upper part and dark yellowish brown in the lower part.

Included with this soil in mapping are small areas of Arvilla, Divide, Marysland, and Sioux soils. These soils make up about 5 to 25 percent of the unit. Arvilla soils have a surface layer and subsoil of sandy loam. They are intermingled with areas of the Renshaw soil. Divide soils are highly calcareous and somewhat poorly drained. They are in swales. Marysland soils are highly calcareous and poorly drained. They are in depressions. Sioux soils have more gravel throughout than the Renshaw soil. They are on knolls and ridges.

Permeability is moderate in the upper part of the Renshaw soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. In most years crops are affected by moisture stress because of the low available water capacity. The main concern in managing cultivated areas is overcoming droughtiness. A system of conservation tillage that leaves tall stubble on the surface and stripcropping help to overcome droughtiness by trapping snow and thus increasing the moisture supply. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Little benefit is derived from fallowing because of the limited available water capacity.

In areas where this soil is used as range, the important forage plants are needleandthread, blue grama, and green needlegrass. Intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, and alfalfa are among the suitable hay and pasture plants. Droughtiness is a problem, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and prevent denuding.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification is IIIe. The productivity index for spring wheat is 38. The range site and pasture group are Shallow to Gravel.

54B—Arvilla sandy loam, 0 to 6 percent slopes. This very deep, level to undulating, somewhat excessively drained soil is on flats and rises on outwash plains. Individual areas range from about 10 to more than 1,000 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is sandy loam about 10 inches thick. It is very dark brown in the upper part and dark yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous gravelly coarse sand. It is brown in the upper part and olive brown in the lower part. In places the surface layer is loam.

Included with this soil in mapping are small areas of Fossum, Renshaw, and Sioux soils. These soils make up about 5 to 25 percent of the unit. Fossum soils are poorly drained. They are in depressions. Renshaw soils have a surface layer and subsoil of loam. They are intermingled with areas of the Arvilla soil. Sioux soils have more gravel throughout than the Arvilla soil. They are on knobs and knolls.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is very slow. Available water capacity is low. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is poorly suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazard of soil blowing is severe, and the hazard of water erosion is slight. In most years crops are affected by moisture stress because of the low available water capacity. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Little benefit is derived from fallowing because of the limited available water capacity.

In areas where this soil is used as range, the important forage plants are needleandthread and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, slender wheatgrass, and alfalfa are among the suitable hay and pasture plants. Soil blowing, water erosion, and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control soil blowing, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 38. The range site and pasture group are Shallow to Gravel.

57—Hamerly-Tonka complex, 0 to 3 percent slopes. These very deep soils are on till plains. The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soil is on flats and on the rim of shallow depressions. The level, poorly drained Tonka soil is in the shallow depressions. Individual areas range from about 10 to more than 200 acres in size. They are about 55 to 65 percent Hamerly soil and 25 to 35 percent Tonka soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is light olive brown, calcareous loam about 21 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Typically, the Tonka soil has a surface soil of black silt loam about 11 inches thick. The subsurface layer is very dark gray silt loam about 10 inches thick. The subsoil is very dark grayish brown, mottled silty clay loam about 20 inches thick. The next layer is dark grayish brown, mottled, calcareous silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is olive, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Cresbard, Parnell, Southam, Svea, and Vallers soils. These included soils make up about 5 to 20 percent of the unit. Cresbard soils have a subsoil of dense clay loam and are moderately well drained. They are in swales. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Svea soils are moderately well drained. They are in swales. Vallers soils are poorly drained. They are on the inner part of the rim of depressions.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. Available water capacity is high in both soils. The seasonal high water table is at a depth of 2.0 to 4.0 feet in the Hamerly soil and is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. Some are used for range, pasture, hay, or wildlife habitat. These soils are suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. If drained, the Tonka soil is well suited to those crops. Wetness delays tillage and seeding in some years on the Hamerly soil and in most years on the Tonka soil. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Tonka soil. The hazard of water erosion is slight on both soils. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are little bluestem, slim sedge, wooly sedge, and big bluestem. Tall wheatgrass, slender wheatgrass, reed canarygrass, creeping foxtail, and sweetclover are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems if the range is grazed when the Tonka soil is wet. They can be overcome by deferring grazing when the soil is wet. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Tonka soil and the ponded water provide an early season breeding site and a good supply of invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

The Hamerly soil and drained areas of the Tonka soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tonka soil, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tonka soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Hamerly soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly soil is IIe, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat is 70 to 83, depending on the degree of drainage in areas of the Tonka soil. The range site of the Hamerly soil is Limy Subirrigated, and that of the Tonka soil is Wet Meadow. The pasture group of the Hamerly soil is Limy Subirrigated, and that of the Tonka soil is Wet.

62—Heimdal-Emrick loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on till plains. The well drained Heimdal soil is on rises and flats. The moderately well drained Emrick soil is in swales. Individual areas range from about 10 to more than 2,000 acres in size. They are about 45 to 65 percent Heimdal soil and 25 to 45 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part, brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In places the subsoil and substratum are clay loam.

Typically, the Emrick soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 36 inches thick. It is very dark grayish brown in the upper part, grayish brown and calcareous in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some places the subsoil and substratum are clay loam. In other places, the surface soil is sandy loam and the substratum is silty clay loam.

Included with these soils in mapping are small areas of Arvilla, Fram, Parnell, and Southam soils. These included soils make up about 5 to 20 percent of the unit. Arvilla soils have a substratum of gravelly coarse sand. They are intermingled with areas of the Heimdal soil. Fram soils are highly calcareous and somewhat poorly drained. They are in swales. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are continuously ponded. They are in deep depressions.

Permeability is moderate in the Heimdal and Emrick soils. Runoff is slow. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. Soil blowing occurs during some storms. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and water erosion.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, big bluestem, and alfalfa are among the suitable hay and pasture plants. No major problems affect the use of these soils as range or pasture.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 84. The range site of the Heimdal soil is Silty, and that of the Emrick soil is Overflow. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Emrick soil is Overflow and Run-on.

62B—Heimdal-Emrick loams, 3 to 6 percent slopes. These very deep, undulating soils are on till plains. The well drained Heimdal soil is on rises. The moderately well drained Emrick soil is in swales. Individual areas range from about 10 to more than 1,000 acres in size. They are about 45 to 65 percent Heimdal soil and 35 to 50 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part, brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In places the subsoil and substratum are clay loam. In a few areas the soil is fine sandy loam throughout.

Typically, the Emrick soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 36 inches thick. It is very dark grayish brown in the upper part, grayish brown and calcareous in the next part, and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some places the subsoil and substratum are clay loam. In other places, the surface soil is sandy loam and the substratum is silty clay loam.

Included with these soils in mapping are small areas of Esmond, Fram, and Parnell soils. These included soils make up about 5 to 20 percent of the unit. Esmond soils have a calcareous subsoil. They are rises. Fram soils are highly calcareous and somewhat poorly drained. They are in swales. Parnell soils are very poorly drained. They are in depressions.

Permeability is moderate in the Heimdal and Emrick soils. Runoff is medium. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight on both soils, and the hazard of water erosion is moderate. Soil blowing occurs during some storms. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control water erosion and soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are among the suitable hay and pasture plants. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 73. The range site of both soils is Silty. The pasture group is Loamy and Silty.

63D—Esmond-Heimdal loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on till plains. The Esmond soil is on shoulder slopes and summits. The Heimdal soil is on side slopes. Individual areas range from about 5 to more than 200 acres in size. They are about 50 to 60 percent Esmond soil and 25 to 40 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Esmond soil has a surface layer of black loam about 4 inches thick. The next layer is dark grayish brown, calcareous loam about 5 inches thick. The subsoil is about 17 inches thick. It is calcareous. It is dark grayish brown sandy loam in the upper part and dark grayish brown and grayish brown loam in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is dark grayish brown in the upper part and olive brown in the lower part. In places the subsoil and substratum are clay loam.

Typically, the Heimdal soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part, brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some places the subsoil and substratum are clay loam. In other places the dark color of the surface layer extends to a depth of 16 inches or more.

Included with these soils in mapping are small areas of Fram, Maddock, Parnell, and Sioux soils. These included soils make up about 5 to 20 percent of the unit. Fram soils are highly calcareous and somewhat poorly drained. They are in swales. Maddock soils have a surface layer of loamy fine sand. They are intermingled with areas of the Heimdal soil. Parnell soils are very poorly drained. They are in depressions. Sioux soils have a substratum of very gravelly sand. They are on ridges.

Permeability is moderate in the Esmond and Heimdal soils. Runoff is rapid. Available water capacity is high. Organic matter content is moderate in the Esmond soil and high in the Heimdal soil.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. These soils generally are unsuited to cultivated crops because of the slope and the hazard of erosion. They are best suited to grasses and legumes for range, pasture, and hay. The hazard of soil blowing is moderate on the Esmond soil and slight on the Heimdal soil. The hazard of water erosion is severe on both soils. The main concerns in managing cultivated areas are maintaining productivity and controlling erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates reduce the hazard of erosion but do not adequately control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Establishing a cover of grasses in cultivated areas helps to maintain productivity and control erosion.

In areas where these soils are used as range, the important forage plants are little bluestem, green needlegrass, needleandthread, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, sideoats grama, and alfalfa are among the suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Esmond soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Heimdal soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of the Esmond soil is VIe, and that of Heimdal soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Esmond soil is Thin Upland, and that of the Heimdal soil is Silty. The pasture group of the Esmond soil is Thin Upland, and that of the Heimdal soil is Loamy and Silty.

63F—Esmond-Heimdal loams, 15 to 35 percent slopes. These very deep, well drained soils are on till plains and moraines dissected by drainageways. The hilly and steep Esmond soil is on ridges and shoulder slopes. The hilly Heimdal soil is on side slopes and summits. Stones or boulders are on some ridges, shoulder slopes, and side slopes. Individual areas range from about 10 to more than 300 acres in size. They are about 45 to 55 percent Esmond soil and 30 to 45 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Esmond soil has a surface layer of black loam about 4 inches thick. The next layer is dark grayish brown, calcareous loam about 5 inches thick. The subsoil is about 17 inches thick. It is calcareous. It is dark grayish brown sandy loam in the upper part and dark grayish brown and grayish brown loam in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is dark grayish brown in the upper part and olive brown in the lower part. In places the subsoil and substratum are clay loam.

Typically, the Heimdal soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part, brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown loam. In places the subsoil and substratum are clay loam.

Included with these soils in mapping are small areas of Emrick, Fram, Parnell, and Sioux soils. These included soils make up about 5 to 20 percent of the unit. Emrick soils are dark to a depth of 16 inches or more. They are in swales. Fram soils are highly calcareous and somewhat poorly drained. They are in swales. Parnell soils are very poorly drained. They are in depressions. Sioux soils have a substratum of very gravelly sand. They are on ridges.

Permeability is moderate in the Esmond and Heimdal soils. Runoff is very rapid. Available water capacity is high. Organic matter content is moderate in the Esmond soil and high in the Heimdal soil.

Most areas are used as range. Some areas are used for cultivated crops, pasture, or hay. These soils generally are unsuited to wheat, oats, and barley and to grasses and legumes for pasture and hay because of the slope and the hazard of erosion.

The important native forage plants are little bluestem, needleandthread, western wheatgrass, and green needlegrass. Water erosion is a hazard, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the important plants helps to control water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Esmond soil is VIIe, and that of the Heimdal soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Esmond soil is Thin Upland, and that of the Heimdal soil is Silty. No pasture group is assigned.

64C—Heimdal-Esmond loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on till plains. The Heimdal soil is on side slopes. The Esmond soil is on shoulder slopes and summits. Individual areas range from about 5 to more than 400 acres in size. They are about 50 to 60 percent Heimdal soil and 25 to 35 percent Esmond soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 23 inches thick. It is dark brown in the upper part, brown in the next part, and olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some places the subsoil and substratum are clay loam. In other places the dark color of the surface layer extends to a depth of 16 inches or more.

Typically, the Esmond soil has a surface layer of black loam about 4 inches thick. The next layer is dark grayish brown, calcareous loam about 5 inches thick. The subsoil is about 17 inches thick. It is calcareous. It is dark grayish brown sandy loam in the upper part and dark grayish brown and grayish brown loam in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is dark grayish brown in the upper part and olive brown in the lower part. In places the subsoil and substratum are clay loam.

Included with these soils in mapping are small areas of Arvilla, Emrick, Parnell, Southam, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Arvilla soils have a substratum of gravelly coarse sand. They are intermingled with areas of the Heimdal soil. Emrick soils are dark to a depth of 16 inches or more. They are in swales. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderate in the Heimdal and Esmond soils. Runoff is rapid. Available water capacity is high. Organic matter content is high in the Heimdal soil and moderate in the Esmond soil. Tilth is good in both soils.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. These soils are suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazard of soil blowing is moderate on the Esmond soil and slight on the Heimdal soil. The hazard of water erosion is severe on both soils. The main concern in managing cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control erosion (fig. 10). Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are little bluestem, green needlegrass, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, sideoats grama, and alfalfa are among the suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an

Figure 10.—An area of Heimdal-Esmond loams, 6 to 9 percent slopes. The grassed waterway in the low area where runoff concentrates helps to control water erosion.

adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Esmond soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Esmond soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Heimdal soil is IIIe, and that of the Esmond soil is IVe. The productivity index of the unit for spring wheat is 50. The range site of the Heimdal soil is Silty, and that of the Esmond soil is Thin Upland. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Esmond soil is Thin Upland.

65B—Maddock loamy fine sand, 0 to 6 percent slopes. This very deep, level and undulating, well drained soil is on flats and rises on lake plains and outwash plains. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface soil is very dark grayish brown loamy fine sand about 11 inches thick. The subsoil is dark brown loamy fine sand about 8 inches thick. The substratum to a depth of about 60 inches is fine sand. It is olive brown in the upper part, olive brown and calcareous in the next part, and grayish brown in the lower part. In some places the surface soil is fine sand or sandy loam. In other places the soil is mottled at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of Fossum and Towner soils. These soils make up about 5 to 20 percent of the unit. Fossum soils are poorly drained. They are in depressions. Towner soils have a substratum of silty clay loam. They are intermingled with areas of the Maddock soil.

Permeability is rapid in the Maddock soil, and runoff is very slow. Available water capacity is low. Organic matter content is moderately low. Tilth is good.

Most areas are used for cultivated crops or hay. Some are used as range or pasture. This soil is poorly suited to wheat, oats, barley, and flax. It is well suited to grasses and legumes for pasture and hay. The hazard of soil blowing is severe, and the hazard of water erosion is slight. In most years crops are affected by moisture stress because of the low available water capacity. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface help to overcome droughtiness by trapping snow and thus increasing the moisture supply. Little benefit is derived from fallowing because of the low available water capacity. Also, fallowing increases the susceptibility to soil blowing.

In areas where this soil is used as range, the important forage plants are needleandthread, prairie sandreed, and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are among the suitable hay and pasture plants. Soil blowing, water erosion, and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 43. The range site and pasture group are Sands.

67B—Lehr loam, 0 to 6 percent slopes. This very deep, level to undulating, somewhat excessively drained soil is on flats and rises on outwash plains. Individual areas range from about 10 to more than 200 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsoil is loam about 8 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, calcareous very gravelly coarse sand. In some places the depth to sand and gravel is more than 20 inches. In other places the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Divide and Wabek soils. These soils make up about 5 to 20 percent of the unit. Divide soils are highly calcareous and somewhat poorly drained. They are in swales. Wabek soils have gravelly coarse sand at a depth of about 12 inches. They are on knolls and ridges.

Permeability is moderately rapid in the upper part of the Lehr soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderately low. Tilth is good.

Most areas are used for cultivated crops. This soil is poorly suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are slight. In most years crops are affected by moisture stress because of the low available water capacity. The main concern in managing cultivated areas is overcoming droughtiness. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface help to overcome droughtiness by trapping snow and thus increasing the moisture supply.

In areas where this soil is used as range, the important forage plants are needleandthread, plains muhly, and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, and alfalfa are among the suitable hay and pasture plants. Water erosion and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control water erosion, and prevent denuding.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. This soil is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification is IIIe. The productivity index for spring wheat is 41. The range site and pasture group are Shallow to Gravel.

73D—Zahl-Williams loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on till plains and on moraines dissected by drainageways. The Zahl soil is on ridges and shoulder slopes. The Williams soil is on side slopes and summits. Stones or boulders are on some ridges, shoulder slopes, and side slopes. Individual areas range from about 10 to more than 500 acres in size. They are about 55 to 65 percent Zahl soil and 25 to 35 percent Williams soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zahl soil has a surface layer of very dark brown, calcareous loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous clay loam. In places the surface layer is black.

Typically, the Williams soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam. In some places the layer of clay accumulation is within a depth of 10 inches. In other places the subsoil is loam. In some areas the surface layer and subsoil are fine sandy loam. In other areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Hamerly, Parnell, Southam, Tonka, and Wabek soils. These included soils make up about 5 to 20 percent of the unit. Hamerly soils are highly calcareous and somewhat poorly drained. They are on flats. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions. Wabek soils have a substratum of very gravelly coarse sand. They are on ridges.

Permeability is moderately slow in the Zahl and Williams soils. Runoff is rapid. Available water capacity is high. Organic matter content is moderately low in the Zahl soil and high in the Williams soil.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. These soils generally are unsuited to cultivated crops because of the slope and the hazard of erosion. They are best suited to grasses and legumes for range, pasture, or hay. The main concerns in managing cultivated areas are maintaining productivity and controlling erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and grassed waterways in areas where runoff concentrates reduce the hazard of erosion but do not adequately control erosion. Establishing a cover of grasses in cultivated areas helps to maintain productivity and control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are little bluestem, green needlegrass, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Zahl soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Williams soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of the Zahl soil is VIe, and that of the Williams soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, and that of the Williams soil is Silty. The pasture group of the Zahl soil is Thin Upland, and that of the Williams soil is Loamy and Silty.

73F—Zahl-Williams loams, 15 to 35 percent slopes. These very deep, hilly and steep, well drained soils are on till plains and on moraines dissected by drainageways. The Zahl soil is on ridges and shoulder slopes. The Williams soil is on side slopes and summits. Stones or boulders are on some ridges, shoulder slopes, and side slopes. Individual areas range from about 10 to more than 2,000 acres in size. They are about 60 to 75 percent Zahl soil and 20 to 40 percent Williams soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zahl soil has a surface layer of very dark brown, calcareous loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous clay loam.

Typically, the Williams soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of the substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam. In some places the layer of clay accumulation is within a depth of 10 inches. In other places the subsoil is loam. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Maddock, Parnell, Southam, Tonka, and Wabek soils. These included soils make up about 5 to 25 percent of the unit. Maddock soils have a surface soil and subsoil of loamy fine sand. They are intermingled with areas of the Williams soil. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions. Wabek soils have a substratum of very gravelly coarse sand. They are on ridges.

Permeability is moderately slow in the Zahl and Williams soils. Runoff is very rapid. Available water capacity is high. Organic matter content is moderate in the Zahl soil and high in the Williams soil.

Most areas are used as range. Some areas are used for cultivated crops, pasture, or hay. These soils generally are unsuited to cultivated crops and to grasses and legumes for pasture and hay because of the slope and the hazard of erosion. They are best suited to range.

The important native forage plants are little bluestem, green needlegrass, and western wheatgrass. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of both soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, and that of the Williams soil is Silty. No pasture group is assigned.

74—Fram loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats and rises on till plains. Individual areas range from about 5 to more than 150 acres in size.

Typically, the surface layer is black, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 24 inches thick. It is light yellowish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous loam. It is mottled in the lower part. In places the substratum is clay loam.

Included with this soil in mapping are small areas of Emrick, Parnell, Southam, Tonka, and Vallers soils. These soils make up about 5 to 20 percent of the unit. Emrick soils are moderately well drained. They are on rises. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Tonka and Vallers soils are poorly drained. Tonka soils are in shallow depressions. Vallers soils are on the inner rim of the depressions.

Permeability is moderate in the Fram soil, and runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 2 to 6 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. This soil is suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. Wetness delays tillage and seeding in some years. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are little bluestem, big bluestem, and switchgrass. Tall wheatgrass, slender wheatgrass, smooth bromegrass, and sweetclover are among the suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 78. The range site and pasture group are Limy Subirrigated.

75—Fram-Tonka complex, 0 to 3 percent slopes. These very deep soils are on till plains. The level and nearly level, somewhat poorly drained, highly calcareous Fram soil is on flats and rises on the rim of shallow depressions. The level, poorly drained Tonka soil is in the shallow depressions. It is subject to ponding. Individual areas range from about 10 to more than 200 acres in size. They are about 55 to 65 percent Fram soil and 25 to 35 percent Tonka soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Fram soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is calcareous loam about 24 inches thick. It is light yellowish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous loam. It is mottled in the lower part. In places the substratum is clay loam.

Typically, the Tonka soil has a surface soil of black silt loam about 11 inches thick. The subsurface layer is very dark gray silt loam about 10 inches thick. The subsoil is very dark grayish brown, mottled silty clay loam about 20 inches thick. The next layer is dark grayish brown, mottled, calcareous silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is olive, mottled, calcareous clay loam. In places the subsoil has less clay.

Included with these soils in mapping are small areas of Emrick, Parnell, Southam, and Vallers soils. These included soils make up about 5 to 20 percent of the unit. Emrick soils are moderately well drained. They are on rises. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Vallers soils are poorly drained. They are on the inner rim of the depressions.

Permeability is moderate in the Fram soil and slow in the Tonka soil. Runoff is slow on the Fram soil and ponded on the Tonka soil. Available water capacity is high in both soils. The seasonal high water table is at a depth of 2.0 to 6.0 feet in the Fram soil and is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. Some are used for range, pasture, hay, or wildlife habitat. The Fram soil is suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. If drained, the Tonka soil is well suited to those crops. Wetness delays tillage and seeding in some years on the Fram soil and in most years on the Tonka soil. The hazard of soil blowing is moderate on the Fram soil and slight on the Tonka soil. The hazard of water erosion is slight on both soils. The main concern in managing cultivated areas is controlling soil blowing. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are little bluestem, slim sedge, wooly sedge, and big bluestem. Tall wheatgrass, slender wheatgrass, reed canarygrass, creeping foxtail, and sweetclover are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems if the range or pasture is grazed when the Tonka soil is wet. They can be overcome by deferring grazing when the soil is wet. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Tonka soil and the ponded water provide an early season breeding site and a good supply of invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and preventing siltation.

The Fram soil and drained areas of the Tonka soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tonka soil, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tonka soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Fram soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Fram soil is IIe, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat is 70 to 84, depending on the degree of drainage in areas of the Tonka soil. The range site of the Fram soil is Limy Subirrigated, and that of the Tonka soil is Wet Meadow. The pasture group of the Fram soil is Limy Subirrigated, and that of the Tonka soil is Wet.

76C—Sioux-Arvilla complex, 1 to 9 percent slopes. These very deep, nearly level to gently rolling soils are on outwash plains. The excessively drained Sioux soil is on knolls and knobs. The somewhat excessively drained Arvilla soil is on flats and rises. Individual areas range from about 20 to more than 400 acres in size. They are about 40 to 60 percent Sioux soil and 25 to 40 percent Arvilla soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sioux soil has a surface layer of black loam about 6 inches thick. The next layer is very dark grayish brown, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is calcareous very gravelly sand. It is dark yellowish brown in the upper part and olive brown in the lower part. In some places the surface layer is gravelly loam. In other places the substratum has thin layers of sand.

Typically, the Arvilla soil has a surface layer of black sandy loam about 7 inches thick. The subsoil is sandy loam about 10 inches thick. It is very dark brown in the upper part and dark yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous gravelly coarse sand. It is brown in the upper part and olive brown in the lower part. In some places the surface layer is gravelly loam. In other places the surface layer and subsoil are loam.

Included with these soils in mapping are small areas of Divide, Fossum, and Marysland soils. These included soils make up about 5 to 20 percent of the unit. Divide and Marysland soils are highly calcareous. Divide soils are somewhat poorly drained. They are in swales. Fossum and Marysland soils are poorly drained. They are in depressions.

Permeability is rapid in the Sioux soil. It is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is slow on both soils. Available water capacity is low. Organic matter content is moderately low in the Sioux soil and moderate in the Arvilla soil.

Most areas are used as range. Some are used for cultivated crops, pasture, or hay. These soils generally are unsuited to cultivated crops because of the hazard of erosion and droughtiness.

The important native forage plants are needleandthread, green needlegrass, western wheatgrass, and plains muhly. Crested wheatgrass, slender wheatgrass, green needlegrass, and alfalfa are among the suitable hay and pasture plants. Soil blowing, water erosion, and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control soil blowing and water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Sioux soil generally is unsuited to the climatically adapted trees and shrubs grown as environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Arvilla soil is suited to some of the climatically adapted species. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing during the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Arvilla soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Sioux soil is VIs, and that of the Arvilla soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Sioux soil is Very Shallow, and that of the Arvilla soil is Shallow to Gravel. The pasture group of the Sioux soil is Very Shallow to Gravel, and that of the Arvilla soil is Shallow to Gravel.

77B—Nutley silty clay, 0 to 6 percent slopes. This very deep, level to undulating, well drained soil is on flats and rises on lake plains. Individual areas range from about 10 to more than 300 acres in size.

Typically, the surface layer is very dark gray, calcareous silty clay about 7 inches thick. The subsoil is calcareous silty clay about 30 inches thick. It is dark grayish brown in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled, calcareous silty clay. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Barnes, Buse, Cresbard, Hamerly, Overly, and Tonka soils. These soils make up about 5 to 20 percent of the unit. Barnes, Cresbard, and Overly soils are intermingled with areas of the Nutley soil. Barnes soils are loam and clay loam throughout. Cresbard soils have a dense, sodic subsoil. Overly soils are moderately well drained and have less clay throughout than the Nutley soil. Buse soils are loam and clay loam throughout. They are on knobs and knolls. Hamerly soils are highly calcareous and somewhat poorly drained. They are on flats. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is slow in the Nutley soil, and runoff is medium. Available water capacity is moderate. Organic matter content is high. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture and hay. The hazards of soil blowing and water erosion are moderate. The main concern in managing cultivated areas is controlling erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Smooth bromegrass, big bluestem, and alfalfa are among the suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 80. The range site and pasture group are Clayey.

79F—Arvilla and Sioux soils, 9 to 35 percent slopes. These very deep soils are on outwash plains. The rolling and hilly, somewhat excessively drained Arvilla soil is on knobs and knolls. The rolling to steep, excessively drained Sioux soil is on rises. Any one area can consist of all Arvilla soil, all Sioux soil, or a combination of both soils. Individual areas range from about 20 to more than 500 acres in size.

Typically, the Arvilla soil has a surface layer of black sandy loam about 7 inches thick. The subsoil is sandy loam about 10 inches thick. It is very dark brown in the upper part and dark yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous gravelly coarse sand. It is brown in the upper part and olive brown in the lower part. In some places the surface layer is gravelly loam. In other places the surface layer and subsoil are loam.

Typically, the Sioux soil has a surface layer of black loam about 6 inches thick. The next layer is very dark grayish brown, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is calcareous very gravelly sand. It is dark yellowish brown in the upper part and olive brown in the lower part. In some places the surface layer is gravelly loam. In other places the substratum has thin layers of sand.

Included with these soils in mapping are small areas of Divide, Fossum, and Marysland soils. These included soils make up about 5 to 20 percent of the unit. Divide soils are highly calcareous and somewhat poorly drained. They are in swales. Fossum and Marysland soils are poorly drained. They are in depressions. Marysland soils are highly calcareous.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. It is rapid in the Sioux soil. Runoff is medium on both soils. Available water capacity is low. Organic matter content is moderately low.

Most areas are used as range. These soils generally are unsuited to cultivated crops because of the slope, the hazard of erosion, and droughtiness. They are best suited to range, pasture, and hay.

The important native forage plants are needleandthread, green needlegrass, western wheatgrass, and plains muhly. Crested wheatgrass, green needlegrass, and western wheatgrass are among the suitable hay and pasture plants. Soil blowing, water erosion, and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soils, control soil blowing and water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Arvilla soil is VIe, and that of the Sioux is VIIs. The productivity index of the unit for spring wheat is 0. The range site of the Arvilla soil is Shallow to Gravel, and that of the Sioux soil is Very Shallow. The pasture group of the Arvilla soil is Shallow to Gravel, and that of the Sioux soil is Very Shallow to Gravel.

81C—Wabek sandy loam, 1 to 9 percent slopes. This very deep, nearly level to gently rolling, excessively drained soil is on knolls and knobs on outwash plains. Individual areas range from about 10 to more than 300 acres in size.

Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The next layer is dark brown gravelly loamy sand about 5 inches thick. The substratum to a depth of about 60 inches is calcareous very gravelly coarse sand. It is dark grayish brown in the upper part and olive brown in the lower part. In places the surface layer is gravelly loam or loam.

Included with this soil in mapping are small areas of Arvilla and Lehr soils. These soils make up about 5 to 20 percent of the unit. They are in swales. Arvilla soils have gravelly coarse sand below a depth of 14 inches and are somewhat excessively drained. Lehr soils have a surface layer and subsoil of loam.

Permeability is very rapid in the Wabek soil, and runoff is slow. Available water capacity is very low. Organic matter content is moderately low.

Most areas are used as range. This soil generally is unsuited to cultivated crops because of the slope and droughtiness.

The important native forage plants are needleandthread and western wheatgrass. Crested wneatgrass and green needlegrass are among the suitable hay and pasture plants. Water erosion and drought are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Very Shallow. The pasture group is Very Shallow to Gravel.

81F—Wabek sandy loam, 9 to 35 percent slopes. This very deep, rolling to steep, excessively drained soil is on knolls and knobs on outwash plains. Individual areas range from about 10 to more than 250 acres in size.

Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The next layer is dark brown gravelly loamy sand about 5 inches thick. The substratum to a depth of about 60 inches is calcareous very gravelly coarse sand. It is dark grayish brown in the upper part and olive brown in the lower part. In places the surface layer is loam or gravelly loam.

Included with this soil in mapping are small areas of Arvilla and Lehr soils. These soils make up about 5 to 20 percent of the unit. They are in swales. Arvilla soils have gravelly coarse sand below a depth of 14 inches. Lehr soils have a surface layer and subsoil of loam.

Permeability is very rapid in the Wabek soil, and runoff is medium. Available water capacity is very low. Organic matter content is moderately low.

Most areas are used as range. This soil generally is unsuited to cultivated crops, to trees and shrubs, and to grasses and legumes for pasture and hay because of the slope and droughtiness.

The important native forage plants are needleandthread and western wheatgrass. Water erosion and drought are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants at a height that traps snow helps to store water in the soil, control water erosion, and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The land capability classification is VIIs. The productivity index for spring wheat is 0. The range site is Very Shallow. No pasture group is assigned.

83B—Williams-Bowbells loams, 3 to 6 percent slopes. These very deep, undulating, well drained soils are on till plains. The Williams soil is on rises. The Bowbells soil is in swales. Individual areas range from about 10 to more than 300 acres in size. They are about 45 to 65 percent Williams soil and 35 to 45 percent Bowbells soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of the substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam. In some places the surface layer is clay loam. In other places the soil is nearly level.

Typically, the Bowbells soil has a surface layer of black loam about 8 inches thick. The subsoil is clay loam about 22 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, dark grayish brown and calcareous, and grayish brown and calcareous. The substratum to a depth of about 60 inches is calcareous. It is grayish brown loam in the upper part and olive brown, mottled clay loam in the lower part. In places the soil is level.

Included with these soils in mapping are small areas of Cathay, Hamerly, Parnell, Southam, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. Cathay soils have a dense, sodic subsoil and are moderately well drained. They are intermingled with areas of the Bowbells soil. Hamerly soils are highly calcareous and somewhat poorly drained. They are on flats. Parnell and Southam soils are very poorly drained. Parnell soils are in depressions. Southam soils are in deep depressions. Tonka soils are poorly drained. They are in shallow depressions.

Permeability is moderately slow in the Williams and Bowbells soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Williams soil and moderate in the Bowbells soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, and sunflowers and to grasses and legumes for pasture or hay. The hazard of soil blowing is slight on both soils, and the hazard of water erosion is moderate. The main concern in managing cultivated areas is controlling water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are among the suitable hay and pasture plants. Maintaining an adequate cover of the important or suitable plants helps to protect the soils from water erosion.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Bowbells soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 80. The range site of both soils is Silty. The pasture group is Loamy and Silty.

86C—Williams-Zahl loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on till plains. The Williams soil is on side slopes, and the Zahl soil is on shoulder slopes and summits (fig. 11). Individual areas range from about 10 to more than 500 acres in size. They are about 45 to 60 percent Williams soil and 35 to 45 percent Zahl soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of the substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam. In some places the subsoil is gravelly loam or loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Zahl soil has a surface layer of very dark brown, calcareous loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous clay loam.

Included with these soils in mapping are small areas

Figure 11.—An area of Williams-Zahl loams, 6 to 9 percent slopes. The Zahl soil is in the light colored areas, and the Williams soil is in the dark colored areas.

of Lehr, Parnell, and Southam soils. These included soils make up about 5 to 20 percent of the unit. Lehr soils have a substratum of very gravelly coarse sand. They are intermingled with areas of the Williams soil. Parnell and Southam soils are in deep depressions. They are very poorly drained. Southam soils are continuously ponded.

Permeability is moderately slow in the Williams and Zahl soils. Runoff is rapid. Available water capacity is high. Organic matter content is high in the Williams soil and moderately low in the Zahl soil. Tilth is good in both soils.

Most areas are used for cultivated crops. Some are used for range, pasture, or hay. These soils are suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. The hazard of soil blowing is slight on the Williams soil and moderate on the Zahl soil. The hazard of water erosion is severe on both soils. The main concern in managing cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are little bluestem, green needlegrass, and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, prairie sandreed, and alfalfa are among the suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Zahl soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Zahl soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Williams soil is IIIe, and that of the Zahl soil is IVe. The productivity index of the unit for spring wheat is 49. The range site of the Williams soil is Silty, and that of the Zahl soil is Thin Upland. The pasture group of the Williams soil is Loamy and Silty, and that of the Zahl soil is Thin Upland.

95—Pits, sand and gravel. This unit is in areas from which the soil has been removed and the underlying sand and gravel mined. The areas generally support little or no vegetation. They range from about 3 to 80 acres in size.

Many of the pits are abandoned. This unit generally is unsuited to agricultural uses unless the areas are leveled, topdressed with suitable topsoil, and otherwise reclaimed. In unreclaimed areas planting climatically adapted trees and shrubs can enhance wildlife habitat or increase the esthetic value. The suitability for individual species of trees and shrubs varies from pit to pit.

The land capability classification is VIIIs. The productivity index for spring wheat is 0. No range site or pasture group is assigned.

99C—Williams-Zahl-Parnell complex, 0 to 9 percent slopes. These very deep soils are on moraines. The well drained, nearly level to gently rolling Williams soil is on side slopes. The well drained, undulating and gently rolling Zahl soil is on shoulder slopes, knobs, and knolls. The very poorly drained, level Parnell soil is in depressions. It is subject to ponding. Individual areas range from about 20 to more than 1,500 acres in size. They are about 40 to 50 percent Williams soil, 30 to 40 percent Zahl soil, and 20 to 30 percent Parnell soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of the substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam. In places the subsoil is gravelly loam or loam.

Typically, the Zahl soil has a surface layer of very dark brown, calcareous loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous clay loam.

Typically, the Parnell soil has a black surface soil about 13 inches thick. The surface soil is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay. In some places the soil has a subsurface layer, which is 2 to 4 inches thick. In other places the subsoil is calcareous.

Included with these soils in mapping are small areas of Bowbells, Hamerly, Lehr, Southam, Vallers, and Wabek soils. These included soils make up about 5 to 15 percent of the unit. Bowbells soils are dark to a depth of more than 16 inches. They are in swales. Hamerly and Vallers soils are highly calcareous. Hamerly soils are on the outer rim of depressions, and Vallers soils are on the inner rim. Lehr soils have a substratum of very gravelly coarse sand. They are intermingled with areas of the Williams soil. Southam soils are very poorly drained and are continuously ponded. They are in deep depressions. Wabek soils are excessively drained. They are on knobs and ridges.

Permeability is moderately slow in the Williams and Zahl soils and slow in the Parnell soil. Runoff is rapid on the Williams and Zahl soils and ponded on the Parnell soil. Available water capacity is high in all three soils. The seasonal high water table is 2 feet above to 2 feet below the surface of the Parnell soil. Organic matter content is moderate in the Williams soil, moderately low in the Zahl soil, and high in the Parnell soil.

Most areas are used for cultivated crops. Some areas are used for range, pasture, or hay. The Williams and Zahl soils are suited to wheat, oats, barley, and flax and to grasses and legumes for pasture and hay. If drained, the Parnell soil also is suited to those crops. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas of the Parnell soil, ponding usually prevents or delays seeding or harvesting and crops are harvested in only 1 or 2 years out of 10. The hazard of soil blowing is moderate on the Zahl soil and slight on the Williams and Parnell soils. The hazard of water erosion is severe on the Williams and Zahl soils and slight on the Parnell soil. The main concern in managing cultivated areas is controlling soil blowing and water erosion. A system of conservation tillage that leaves crop residue on the surface, stripcropping, field windbreaks, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, little bluestem, and needleandthread on the Williams and Zahl soils and slough sedge and rivergrass on the Parnell soil. Smooth bromegrass, intermediate wheatgrass, big bluestem, green needlegrass, reed canarygrass, creeping foxtail, and alfalfa are among the suitable hay and pasture plants. Compaction, trampling, and root shearing are problems if the range or pasture is grazed when the Parnell soil is wet. They can be overcome by deferring grazing while the soil is wet. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion.

The Parnell soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Zahl soil is suited to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. If drained, the Parnell soil is suited to all of the climatically adapted species. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Parnell soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs on the Zahl soil help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Williams soil is IIIe, that of the Zahl soil is IVe, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 46 to 58, depending on the degree of drainage in areas of the Parnell soil. The range site of the Williams soil is Silty, that of the Zahl soil is Thin Upland, and that of the Parnell soil is Wetland. The pasture group of the Williams soil is Loamy and Silty, that of the Zahl soil is Thin Upland, and that of drained areas of the Parnell soil is Wet.

99F—Zahl-Williams-Parnell complex, 0 to 35 percent slopes. These very deep soils are on moraines. The well drained, rolling to steep Zahl soil is on shoulder slopes, ridges, knobs, and knolls. The well drained, rolling to steep Williams soil is on side slopes. The very poorly drained, level Parnell soil is in depressions. It is subject to ponding. Stones and boulders are on some of the shoulder slopes and convex side slopes and on the rims of some depressions. Individual areas range from about 20 to more than 2,000 acres in size. They are about 40 to 50 percent Zahl soil, 30 to 40 percent Williams soil, and 20 to 30 percent Parnell soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zahl soil has a surface layer of very dark brown, calcareous loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown and light olive brown, calcareous clay loam.

Typically, the Williams soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is clay loam about 22 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and calcareous in the lower part. The upper part of the substratum is dark grayish brown and grayish brown, calcareous clay loam. The lower part to a depth of about 60 inches is olive brown, calcareous loam. In places the subsoil is loam.

Typically, the Parnell soil has a black surface soil about 13 inches thick. The surface soil is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay about 24 inches thick. It is mottled in the lower part. The next layer is very dark gray, mottled silty clay about 19 inches thick. The substratum to a depth of about 60 inches is dark olive gray, mottled silty clay. In some places the soil has a subsurface layer, which is 2 to 4 inches thick. In other places the subsoil is calcareous.

Included with these soils in mapping are small areas of Hamerly, Southam, Vallers, and Wabek soils. These included soils make up about 5 to 15 percent of the unit. Hamerly and Vallers soils are calcareous throughout. Hamerly soils surround the depressions, and Vallers soils are in the depressions. Southam soils are very poorly drained. They are in deep depressions. Wabek soils are excessively drained. They are on knobs and ridges.

Permeability is moderately slow in the Zahl and Williams soils and slow in the Parnell soil. Runoff is very rapid on the Zahl and Williams soils and ponded on the Parnell soil. Available water capacity is high in all three soils. The seasonal high water table is 2 feet above to 2 feet below the surface of the Parnell soil. Organic matter content is moderately low in the Zahl soil and high in the Williams and Parnell soils.

In most areas these soils are used as range or wildlife habitat. They are best suited to these uses. They generally are unsuited to wheat, oats, and barley and to grasses and legumes for pasture and hay because of the slope and the hazard of erosion on the Zahl and Williams soils.

The important native forage plants are western wheatgrass, green needlegrass, little bluestem, and needleandthread on the Zahl and Williams soils and slough sedge and rivergrass on the Parnell soil. Compaction, trampling, and root shearing are problems if the range is grazed when the Parnell soil is wet. They can be overcome by deferring grazing when the Parnell soil is wet. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion and prevent denuding.

The Parnell soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The Zahl and Williams soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. If drained, the Parnell soil is suited to all of the climatically adapted species. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tonka soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of the seedlings.

The land capability classification of the Zahl soil is VIIe, that of the Williams soil is VIe, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, that of the Williams soil is Silty, and that of the Parnell soil is Wetland. No pasture group is assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 180,000 acres in the survey area, or nearly 28 percent of the total acreage, meets the soil requirements for prime farmland.

The map units in the survey area that are considered prime farmland are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

2	Marysland loam (where drained)
15	Divide loam, 0 to 3 percent slopes
19	Tonka silt loam (where drained)
30	Svea-Barnes loams, 0 to 3 percent slopes
30B	Barnes-Svea loams, 3 to 6 percent slopes
35B	Overly silty clay loam, 0 to 6 percent slopes
44B	Swenoda sandy loam, 0 to 6 percent slopes
57	Hamerly-Tonka complex, 0 to 3 percent slopes (where the Tonka soil is drained)
62	Heimdal-Emrick loams, 0 to 3 percent slopes
62B	Heimdal-Emrick loams, 3 to 6 percent slopes
74	Fram loam, 0 to 3 percent slopes
75	Fram-Tonka complex, 0 to 3 percent slopes (where the Tonka soil is drained)
77B	Nutley silty clay, 0 to 6 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Prepared by Douglas A. Gasseling, agronomist, and Jay T. Mar, district conservationist, Soil Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the North Dakota Cooperative Extension Service.

About 64 percent of Sheridan County is cultivated. In 1990, about 179,100 acres was used for close-grown crops, 34,000 acres for row crops, and 66,000 acres for forage crops *(8)*. During the period 1985 to 1989, the acreage used for close-grown crops averaged 178,750 acres per year. The acreage of summer fallow was 85,000 acres in 1987, about 90,000 acres in 1988, and 50,000 acres in 1989 *(7)*. The acreage used for sunflowers is decreasing. It averaged 44,100 acres per year from 1985 to 1988. It was 35,500 acres in 1989 and 29,000 acres in 1990 *(8)*. The acreage used for corn and forage has been stable in recent years. In 1990, the acreages of the principal close-grown crops were as follows—spring wheat, 125,000 acres; durum wheat, 3,500 acres; winter wheat, 600 acres; barley, 24,500 acres; oats, 18,500 acres; and flax, 7,000 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 29,000 acres and corn on 5,000 acres. Alfalfa was grown on 16,000 acres and other hay crops on 50,000 acres. Small acreages were planted to mustard, buckwheat, rye, sorghum, millet, and safflower. In 1990, approximately 65,300 acres was enrolled in the Conservation Reserve Program.

The potential of the soils in Sheridan County for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate of the county are suited to most of the crops that are commonly grown in the survey area. The crops that are not commonly grown but are suitable include lentils, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper utilization of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on some of the soils in Sheridan County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Arvilla, Fossum, Maddock, Swenoda, Towner, and Wabek soils.

Buse, Divide, Esmond, Fram, Hamerly, Marysland, Vallers, and Zahl soils have a relatively high content of lime and are susceptible to soil blowing in spring if they have been left unprotected throughout winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are left unprotected.

Water erosion is a severe hazard on gently sloping and steeper soils, such as Barnes, Buse, Esmond, Heimdal, Williams, and Zahl soils. It also is a severe hazard on the more gently sloping soils having long slopes. The hazard is greatest when the surface is left unprotected.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of herbicide can help to eliminate the need for summer fallow tillage. Cover crops also are effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. Inclusion of grasses and legumes in the cropping sequence, grassed waterways, diversions, terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that includes several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to the success of the crop during the growing season. In years when the amount of available soil moisture is low at planting time, the success of cropping is greatly reduced. Measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds conserve moisture. Examples are stubble mulching; a system of conservation tillage, such as no-till farming; stripcropping; cover crops; crop residue management; standing stubble and annual wind barriers, which trap snow; and applications of fertilizer. When fallow is used to carry moisture over to the next season, a cover of crop residue is essential during winter to guard against moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on many soils. Examples are applications of commercial fertilizer, green manure crops, inclusion of legumes in the cropping sequence, and applications of barnyard manure.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on the soils that have a surface layer of silty clay loam, clay loam, or silty clay. Nutley soils are an example. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases the susceptibility to erosion.

Management of Saline and Sodic Soils

Saline and sodic soils make up about 6 percent of Sheridan County. Saline soils make up about 1 percent of the county, or 6,400 acres; sodic soils make up 3 percent, or 19,700 acres; and saline-sodic soils make up 2 percent, or 11,600 acres.

Saline soils have a high concentration of soluble salts, or salts that dissolve in water. The saline soils in Sheridan County are phases of the Fram and Vallers series.

Saline soils generally develop in areas of restricted drainage adjacent to natural sloughs and drainageways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by plants and a surface cover. The plant roots use the soil water before it can reach the surface and before the salts accumulate. The surface cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the water in the soils. Excess amounts of certain salts may interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts are generally not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts are usually visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain crop growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can be used for salt-tolerant crops and forage. Barley is the most salt tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt tolerant once they are established.

Sodic soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soils. The sodic soils in Sheridan County are those of the Cathay, Cavour, Cresbard, and Larson series. Locally, sodic soils are known as "black-alkali," "slick spots," "pan spots," or "gumbo."

Sodic soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the sodic soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10 feet.

Sodic soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, rainwater gradually leaches the salts from the surface to the lower horizons as the water table lowers. During this leaching process, the clay in the soils becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, sodic subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. Miranda soils are an example of soils that have a dense, sodic subsoil.

As leaching by water in the soils continues, the sodium is gradually moved lower in the profile and eventually is carried below the rooting depth. The result is a more manageable soil, such as Cathay and Cresbard soils. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonsodic soil. This change requires a long period, usually centuries *(6)*.

If plowed, sodic soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils do not favor plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by depth to the dense subsoil.

Identification of sodic soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of moisture stress, is a useful indicator of the level of sodicity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of sodicity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effect of sodicity on plant growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the growth of these crops.

The variability of sodic soils can cause management problems. The sodic soils that have salts within a depth of 16 inches, such as Miranda soils, are generally best suited to native grasses. The soils that have a dense, sodic subsoil near the surface are generally unsuited to small grain and sunflowers.

Timely tillage is an important management need in areas of leached sodic soils, such as Cathay and Cresbard soils. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when too dry, tillage and seeding implements cannot easily penetrate the soils. Deep plowing and chemical amendments can help to reclaim sodic soils, but they may not be feasible. To be effective, deep tillage should reach to the sodic subsoil and mix several inches of the underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of sodic soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-sodic soils develop in areas of restricted drainage where salts rise with the water table but where some downward leaching downward of clay and some saturation with sodium are evident and a dense, sodic subsoil has formed. The saline-sodic soils in Sheridan County are those of the Harriet and Miranda series (fig. 12). The management needs and crop responses

Figure 12.—An area of strongly saline and sodic Harriet soils. In the light colored areas, salts on the surface prevent or severely limit plant growth.

on these soils are a combination of those on saline soils and those on sodic soils.

Additional information about management or reclamation of saline and sodic soils is available from the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the North Dakota Cooperative Extension Service.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison to other map units. The index ranges from 0, which indicates no yield, to 100 which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. In Sheridan County a productivity index of 100 was considered equal to an average annual yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 will convert the index number to a figure representing the expected average annual yield per acre. Svea-Barnes loams, 0 to 3 percent slopes, for example has a productivity index of 87, which when multiplied by 40 and then divided by 100, converts to 35, which is the expected average annual yield of spring wheat in bushels per acre for this map unit. (See table 5).

Pasture Groups

The following paragraphs describe the pasture groups in the survey area. They specify the production potential under improved management and the representative adapted forage species for each group. The names of the groups are Clayey, Clayey Subsoil, Claypan, Limy Subirrigated, Loamy and Silty, Overflow and Run-on, Saline, Sands, Sandy, Shallow to Gravel, Sodic and Saline, Thin Claypan, Thin Upland, Very Shallow to Gravel, and Wet.

Clayey pasture group. This group of soils has a relatively high content of clay. The production potential is high. Suitable forage species include smooth bromegrass, Russian wildrye, western wheatgrass, green needlegrass, big bluestem, indiangrass, switchgrass, alfalfa, and sweetclover.

Clayey Subsoil pasture group. This group of soils has a subsoil that somewhat restricts root penetration. The production potential is moderately high. Suitable forage species include smooth bromegrass, Russian wildrye, western wheatgrass, green needlegrass, switchgrass, alfalfa, and sweetclover.

Claypan pasture group. This group of soils has a dense subsoil that restricts root penetration. The production potential is low. Suitable forage species include western wheatgrass, tall wheatgrass, intermediate wheatgrass, pubescent wheatgrass, slender wheatgrass, alfalfa, and sweetclover.

Limy Subirrigated pasture group. This group of soils has a highly calcareous subsoil. The production potential is high. Suitable forage species include big bluestem, indiangrass, switchgrass, little bluestem, smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, tall wheatgrass, slender wheatgrass, sweetclover, and birdsfoot trefoil.

Loamy and Silty pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of silt and clay and a low content of sand. The production potential is high. Suitable forage species include smooth bromegrass, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, switchgrass, indiangrass, big bluestem, slender wheatgrass, streambank wheatgrass, alfalfa, and sweetclover.

Overflow and Run-on pasture group. This group of soils is in areas that receive additional moisture because of stream overflow or runoff from the surrounding areas. The production potential is high. Suitable forage species include smooth bromegrass, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, altai wildrye, western wheatgrass, thickspike wheatgrass, green needlegrass, slender wheatgrass, big bluestem, indiangrass, switchgrass, alfalfa, and sweetclover.

Saline pasture group. This group of soils has enough salts to interfere with plant growth. The production potential is low. Wetness is a problem. Severely affected areas can be improved, particularly during the establishment period, by mulch, which reduces the extent of surface drying and improves seedling emergence. The better suited forage species include tall wheatgrass, slender wheatgrass, western wheatgrass, beardless wildrye, alkali sacaton, alsike clover, and sweetclover.

Sands pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of sand and a low content of silt and clay. The production potential is moderately high. Suitable forage species include sand bluestem, prairie sandreed, switchgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Sandy pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of sand and a moderate content of silt and clay. The production potential is high. Suitable forage species include green needlegrass, slender wheatgrass, western wheatgrass, intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, sand bluestem, switchgrass, alfalfa, and sweetclover.

Shallow to Gravel pasture group. This group of soils has a substratum that has a relatively high content of sand or sand and gravel at a depth of about 14 to 25 inches. The production potential is moderate. Drought-tolerant forage species grow best. Suitable species include crested wheatgrass, green needlegrass, western wheatgrass, slender wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Sodic and Saline pasture group. This group of soils has a subsoil that restricts root penetration and contains enough salts to interfere with plant growth. The production potential is moderately low. Surface mulch reduces the extent of surface drying and improves seedling emergence. Suitable forage species include tall wheatgrass, western wheatgrass, slender wheatgrass, Russian wildrye, beardless wildrye, switchgrass, alkali sacaton, alsike clover, and sweetclover.

Thin Claypan pasture group. This group of soils has a very dense subsoil that severely restricts root penetration and has enough salts to interfere with plant growth. The production potential is very low. The best suited forage species include western wheatgrass, slender wheatgrass, and alfalfa.

Thin Upland pasture group. This group of soils is in areas that allow runoff of precipitation. The soils have a highly calcareous subsoil. Soil blowing and water erosion are management concerns, particularly during the establishment period. The production potential is moderate. Suitable forage species include smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, western wheatgrass, green needlegrass, little bluestem, prairie sandreed, sideoats grama, sweetclover, and alfalfa.

Very Shallow to Gravel pasture group. This group of soils has a substratum that has a high content of sand or sand and gravel within a depth of 14 inches. The production potential is low. The most drought-tolerant forage species grow best. Suitable species include western wheatgrass, crested wheatgrass, green needlegrass, intermediate wheatgrass, and pubescent wheatgrass.

Wet pasture group. This group of soils is wet. The production potential is very high. The best suited forage species are those that are tolerant of wetness and inundation. Suitable species include reed canarygrass, creeping foxtail, big bluestem, switchgrass, indiangrass, meadow foxtail, and alsike clover.

Yields per Acre

The average yields per acre that can be expected of the principal crops are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the North Dakota Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(16)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations or hazards that restrict their use.

Class II soils have moderate limitations or hazards that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations or hazards that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations or hazards that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations or hazards, impractical to remove, that limit their use.

Class VI soils have severe limitations or hazards that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations or hazards that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations or hazards that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

A. Dean Chamrad and Jeffrey L. Printz, range conservationists, Soil Conservation Service, helped prepare this section.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments, such as applications of fertilizer and cultivation, generally are not used or needed to maintain the productivity of rangeland. The composition and production of the plant community are largely determined by soil, climate, topography, and grazing management.

In 1990, approximately 225,000 acres in Sheridan County, or about 35 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is on loamy glacial till plains and moraines. Much of it occurs as hilly to very steep, well drained or excessively drained soils or as level and nearly level, poorly drained and very poorly drained soils in potholes and depressions. The soils are generally unsuited or poorly suited to cultivated crops.

In 1990, the farms and ranches in the county had about 23,000 head of cattle, including about 2,000 milk cows *(8)*. Most of the ranches are cow-calf enterprises. Some also run stocker yearlings, which add flexibility during periods of low or high forage production. On a few of the farms, raising sheep in conjunction with cattle improves the efficiency of range utilization and results in greater economic stability.

Because of a relatively short growing season, many farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in spring and fall. Droughts of short duration are common. They reduce the benefits derived from cool-season pastures in some years. Generally, large amounts of hay and feed are needed because of long winters. Hay was harvested on about 66,000 acres in the county in 1990 *(8)*.

Range Sites and Condition Classes

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce similar kinds, proportions, and amounts of vegetation are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. The climax vegetation on the prairie consists of the kinds of plants that grew when the region was settled. It is generally, but not always, the most productive combination of plants that can be grown on the site. When the site is improperly grazed, some of the climax plants decrease in quantity, while others increase. Also, plants that were not part of the original native plant community may invade the site.

Decreaser plants are the species that decrease in quantity under heavy, continuous grazing. They generally are the most palatable to livestock.

Increaser plants are the species that initially increase in quantity under heavy, continuous grazing at the expense of the decreaser species. They generally are less palatable to livestock than the decreaser species. Under prolonged heavy grazing, the increaser plants also eventually decrease in quantity.

Invader plants are species that normally are not part of the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by heavy, continuous grazing or other disturbance. Most invader species have limited value as forage. All nonendemic species are invaders in natural plant communities.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the higher the range condition. Range condition is an ecological rating only. It is not a rating of forage value. It is expressed as excellent, good, fair, or poor, depending on how closely the present plant community resembles the natural potential plant community. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent, and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for nearly all of the soils in the county, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range sites. Soil reaction, salt content, and a seasonal high water table also are important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, regardless of palatability to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. Production is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially above average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture or above average temperatures.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as kind of plant, state of growth, exposure, amount of shade, recent rains, and unseasonably dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition and trend. The primary objective in range management is to manipulate grazing in such a manner that the plants growing on a site are similar in kind and amount to the potential natural plant community for that site. Such management generally results in the optimum production and diversity of vegetation, control of undesirable brush and weeds, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Ecologically sound range management maintains excellent or good range condition. Water is conserved, yields are optimized, and soils are protected. An important management concern is recognizing the changes in the plant community that take place gradually and that can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when the plant cover actually is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and a grazing system to restore the rangeland to excellent condition. In areas where the climax plant community has been destroyed, range seeding can accelerate improvement of the range condition. Seeding the proper climax species also can restore productive rangeland in areas of depleted or low-quality cropland. Brush control, water developments, fencing, and other mechanical practices may be needed to facilitate proper grazing management. Proper grazing management is the key to maintaining or improving the productivity and diversity of rangeland.

The following paragraphs describe the range sites in the county. The names of these sites are Clayey, Claypan, Limy Subirrigated, Overflow, Saline Lowland, Sands, Sandy, Shallow to Gravel, Silty, Subirrigated, Thin Claypan, Thin Upland, Very Shallow, Wet Meadow, and Wetland.

Clayey range site. This site is dominated by a mixture of cool-season, mid grasses and an understory of short grasses. The principal species are western wheatgrass, porcupinegrass, needleandthread, and green needlegrass. The understory plants are blue grama, prairie junegrass, Pennsylvania sedge, and other upland sedges. Forbs, such as western yarrow, scarlet globemallow, and green sagewort, make up about 10 percent of the total herbage. The most common woody plants are western snowberry and prairie rose.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, porcupinegrass, green needlegrass, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, needleandthread, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, western ragweed, and fringed sagewort and the invasion of Kentucky bluegrass.

Very few problems affect management of this site. The rate of water infiltration is slow. As a result, an adequate cover of vegetation is needed to help ensure that forage production is not reduced by runoff. Areas where the range is in fair condition can generally be restored to good or excellent condition by proper grazing management if the climax species remain in sufficient numbers and are uniformly distributed.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species are blue grama and upland sedges. The most common forbs are scarlet globemallow, silver scurfpea, rush skeletonplant, and fringed sagewort.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, and upland sedges. Further deterioration results in a dominance of blue grama, inland saltgrass, upland sedges, fringed sagewort, broom snakeweed, and annual grasses and forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and salts in the soils, reestablishing vegetation is difficult in denuded areas. Careful management that maintains an abundance of the naturally dominant plants is the best way to maintain forage production and protect the soil from water erosion.

Limy Subirrigated range site. Tall and mid grasses dominate this site. The principal species are little bluestem, big bluestem, and switchgrass. Other species are indiangrass, slim sedge, fescue sedge, and Baltic rush. Forbs, including Maximilian sunflower, stiff sunflower, American licorice, and Missouri goldenrod, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, indiangrass, switchgrass, Maximilian sunflower, and stiff sunflower. Little bluestem initially increases in abundance under these conditions, but it eventually decreases. Further deterioration results in a dominance of Baltic rush, common spikerush, and annual grasses and forbs and the invasion of Kentucky bluegrass.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system and proper grazing use can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major species of grasses.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, prairie dropseed, switchgrass, fescue sedge, and little bluestem. Several forbs, such as Maximilian sunflower, soft goldenrod, cudweed sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, buffaloberry, and common chokecherry, commonly grow on the site, depending on the position on the landscape. They may make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, and fescue sedge. Further deterioration results in a dominance of blue grama, sedges, and unpalatable forbs and the invasion of Kentucky bluegrass.

Because of its position on the landscape, this site is frequently overgrazed. Separate fencing of this site generally is not feasible because of the small size or the shape of areas of the site. Because it is subject to flooding and receives runoff from the adjacent areas, this site is very productive when properly managed. A planned grazing system can help to restore the site and maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate, brush management can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and other salt-tolerant species, including western wheatgrass and slender wheatgrass. Other species are alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted, desirable salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Livestock ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sands range site. The principal grasses on this site are prairie sandreed, needleandthread, and sand bluestem. Other species are blue grama, prairie junegrass, sand dropseed, western wheatgrass, and upland sedges. Forbs make up about 10 percent of the total herbage. This site has a small amount of woody species, such as prairie rose, western snowberry, and leadplant amorpha.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, little bluestem, sand bluestem, and leadplant amorpha. Needleandthread initially increases in abundance, but it eventually decreases. Other plants that increase in abundance under these conditions are sand dropseed, blue grama, upland sedges, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as fringed sagewort and cudweed sagewort.

A low or very low available water capacity and the hazard of soil blowing are concerns in managing this site. Measures that minimize the formation of livestock trails and the concentration of livestock are needed. In severely overgrazed areas, blowouts are common, especially on knobs and along cattle trails. In areas of large blowouts, shaping, seeding, and mulching are needed before the climax vegetation can be reestablished. In areas where this site is in fair or poor condition, the vegetation responds rapidly to improved grazing management.

Sandy range site. The principal grasses on this site are needleandthread, prairie sandreed, blue grama, and western wheatgrass. Other species are prairie junegrass, sand dropseed, green needlegrass, and upland sedges. The site generally has a number of early season forbs, such as western yarrow, green sagewort, and Missouri goldenrod. Woody plants, such as western snowberry and leadplant amorpha, make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, green needlegrass, prairie sandreed, and leadplant amorpha. The plants that increase in abundance under these conditions are blue grama, upland sedges, sand dropseed, needleandthread, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as western yarrow, green sagewort, and cudweed sagewort.

A moderate available water capacity is a concern in managing this site. Also, soil blowing is a hazard in denuded areas. Management that maintains an abundance of the key species results in a natural plant community that provides excellent forage for livestock and a protective plant cover.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are plains muhly, prairie junegrass, red threeawn, porcupinegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, fringed sagewort, and annual forbs.

A low available water capacity limits forage production on this site. The site is fragile, and the plant community can deteriorate rapidly. Keeping the plant community near its potential and maintaining the vigor of the key plants help to optimize the use of the limited amount of available moisture.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, green needlegrass, needleandthread, and blue grama. Other species are prairie junegrass, prairie dropseed, and upland sedges. Forbs include wooly goldenrod, stiff sunflower, and western yarrow. The site has minor amounts of woody species.

Continual heavy grazing by cattle results in a decrease in the abundance of green needlegrass, western wheatgrass, prairie junegrass, and porcupinegrass. The plants that increase in abundance under these conditions are needleandthread, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagewort. Further deterioration results in a dominance of blue grama, threadleaf sedge, needleleaf sedge, fringed sagewort, green sagewort, and other forbs. As the range condition deteriorates, woody species increase in abundance and Kentucky bluegrass invades.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Proper grazing use and planned grazing systems help to prevent gullying. Areas where the range is in fair or poor condition generally can be restored to good or excellent condition by sound grazing management. Brush management is needed in areas where undesirable woody species have increased in abundance or invaded.

Subirrigated range site. Tall and mid grasses dominate this site. The principal species are big bluestem, switchgrass, prairie cordgrass, little bluestem, and northern reedgrass. Other species are indiangrass, western wheatgrass, tall dropseed, and slender wheatgrass. The site has minor amounts of sedges and rushes. A variety of forbs makes up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, prairie cordgrass, northern reedgrass, indiangrass, and little bluestem. The plants that increase in abundance under these conditions are mat muhly, fowl bluegrass, Baltic rush, common spikerush, and various forbs. Further deterioration results in the invasion of Kentucky bluegrass and a dominance of short grasses, grasslike plants, and undesirable forbs.

Because of the a high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system in conjunction with proper grazing use can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major species of grasses.

Thin Claypan range site. Mid and short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandberg bluegrass. Other species are prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of western wheatgrass, prairie junegrass, and needleandthread. The plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in a dominance of short grasses, sedges, fringed sagewort, annual forbs, and cactus.

Because of salts near the surface of the soils, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, sodic subsoil. Livestock ponds should not be constructed on this site because the water is likely to be salty. Sound management can restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site is denuded, range seeding can restore desirable vegetation, but good seeding techniques are essential.

Thin Upland range site. Cool- and warm-season, mid grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and sideoats grama. Other species are plains muhly, blue grama, prairie dropseed, bearded wheatgrass, and upland sedges. Forbs include pasqueflower, purple prairie-clover, and dotted gayfeather. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, upland sedges, and fringed sagewort; the invasion of Kentucky bluegrass; and an increase in the abundance of woody species.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Gullying can be prevented by proper grazing management and by cross-fencing, which helps to control livestock traffic patterns. Soil blowing is a problem in denuded areas. Areas where the range is in fair and poor condition generally can be restored to good or excellent condition by sound grazing management. In some areas brush control is needed.

Very Shallow range site. This site has a mixture of cool- and warm-season, mid and short grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species are prairie junegrass, red threeawn, sideoats grama, and upland sedges. Forbs and woody plants make up about 15 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, sand dropseed, and upland sedges. Further deterioration results in a dominance of blue grama, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can readily form along cattle trails and in denuded areas. The site is frequently spot grazed. Once it has deteriorated to fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by sound grazing management of the mid grasses.

Wet Meadow range site. Sedges and mid grasses dominate this site. The principal species are slim sedge, wooly sedge, fescue sedge, prairie cordgrass, and northern reedgrass. Other species are Baltic rush, common spikerush, fowl bluegrass, and switchgrass. Common forbs are Rydberg sunflower, tall white aster, and common wild mint.

Continual heavy grazing by cattle results in a decrease in the abundance of slim sedge, wooly sedge, northern reedgrass, prairie cordgrass, and switchgrass. The plants that increase in abundance under these conditions are fescue sedge, common spikerush, Baltic rush, mat muhly, and fowl bluegrass. Further deterioration results in a dominance of low-growing sedges, short grasses, western dock, and Canada thistle.

Generally, this site is subject to lighter grazing pressure than the adjacent upland sites. It is more heavily grazed during droughty periods. This site is easily damaged if it is grazed when wet. Grazing during wet periods results in compaction, trampling, and root shearing. A planned grazing system that includes strategic fencing helps to maintain the climax vegetation.

Wetland range site. Hydrophytic vegetation dominates this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip. Shrubs generally do not grow on this site.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

Generally, this site is subject to lighter grazing pressure than the adjacent upland sites. It is more heavily grazed during droughty periods. This site is easily damaged if it is grazed when wet. Grazing during wet periods results in compaction, trampling, and root shearing. A planned grazing system and deferment of grazing when the soil is wet help to maintain the climax vegetation and the important elements of wetland wildlife habitat.

Woodland, Windbreaks, and Environmental Plantings

Prepared by Bruce C. Wight, forester, Soil Conservation Service.

Sheridan County has approximately 400 acres of native woodland *(9)*. Most of this woodland is in scattered areas throughout the county, surrounding wetlands and lakes and along drainageways with north and northeast aspects. The Prophets Mountain area, in the west-central part of the county, has numerous wooded drainageways occurring primarily as areas of Zahl and Williams loams. The woodland on the side slopes in the valley of the Sheyenne River is mostly in areas of Buse, Barnes, and Svea loams. The woodland on the fringe of some of the lakes occurs as areas of Maddock loamy fine sand.

The forest type on the side slopes in the valley of the Sheyenne River is primarily American elm and green ash. The less common species include boxelder, cottonwood, hawthorn, common chokecherry, American plum, juneberry, woods rose, snowberry, and silverberry. The dominant species along the edge of some of the lakes are quaking aspen, boxelder, cottonwood, and American elm. The less common species include common chokecherry, hackberry, willow, hawthorn, and woods rose. In the Prophets Mountain area, the principal species are common chokecherry and hawthorn. Associated with the chokecherry and hawthorn are green ash, snowberry, woods rose, and silverberry. The principal species on the wooded fringe of the wetlands in the county are quaking aspen, various willow species, and redosier dogwood.

The early settlers used the trees for fuel, lumber, and fenceposts. Currently, there is a renewed interest in using the trees for fuel, but the principal uses are for protection and esthetic purposes. The trees protect the soils, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in Sheridan County since the early days of settlement. Some of these early plantings were made under the Timber Culture Act. Under this act, 160 acres of land was granted to a homesteader who planted 10 acres to trees. Most of the early plantings were made to protect farmsteads and livestock.

Since the 1930's, more than 2,600,000 trees have been planted on about 4,100 acres by county farmers and landowners assisted by the Soil Conservation Service and the Sheridan County Soil Conservation District. This effort has included nearly 1,700 acres of farmstead windbreaks and 900 miles of field windbreaks (fig. 13). Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help to protect soils that are highly susceptible to soil blowing.

The following items should be considered before a planting is made—the purpose of the planting, the suitability of various species of trees and shrubs to the soils and the climate, the location and design of the windbreak, and the selection of hardy seedlings. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the trees and shrubs are planted, and the competing ground cover should be controlled for the life of the windbreak. Some replanting may be necessary during the first 2 years after the trees and shrubs are planted.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the North Dakota Cooperative Extension Service or from a commercial nursery.

Recreation

Prepared by David D. Dewald, biologist, Soil Conservation Service.

The recreational resources of Sheridan County are somewhat limited. Hunting and fishing are the main recreational opportunities available to the residents of the county. Opportunities for fishing and limited primitive camping are available at Hoffer Lake, Coal Mine Lake, and Skunk Lake. Fishing access is limited to designated areas along the McClusky Canal. Northern pike, walleye, bluegill, crappie, and perch are the main species of game fish in the waters.

Four towns in the county have picnicking and limited camping facilities. The county has no State or county parks. A swimming pool is open to the public in McClusky during the summer.

Approximately 24,700 acres managed by the U.S. Fish and Wildlife Service provides opportunities for hunting. The North Dakota State Game and Fish Department will manage approximately 27,000 acres of

Figure 13.—An area of cropland protected from soil blowing by field windbreaks.

wildlife areas as they are developed by the Bureau of Reclamation as part of the Garrison Diversion Irrigation Project. The Bureau of Reclamation is in the process of developing additional wildlife management areas. About 25,600 acres of State school land is open to the public. Many private landowners grant permission to hunt on their land.

The public areas in the county provide opportunities for numerous other recreational activities, including hiking, bird-watching, and cross-country skiing.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Prepared by David D. Dewald, biologist, Soil Conservation Service.

Sheridan County is in the prairie pothole region of North Dakota. It has diverse kinds of wildlife habitat. Since settlement, agricultural activity has reduced the quality and quantity of rangeland and wetland wildlife habitat but has increased the amount of openland wildlife habitat. About 35 percent of the original rangeland habitat remains. The diversity of the wildlife habitat is enhanced by the numerous wetlands in the county. Drainage systems installed to improve crop production have removed approximately 15 percent of the original wetland habitat. The remaining wetlands provide habitat for waterfowl and furbearers.

Private landowners have planted more than 4,000 acres of field and farmstead shelterbelts, which provide habitat for resident and migratory wildlife species. Also, private landowners have protected approximately 24,700 acres of wetlands by conveying their drainage rights to the Federal Government through the Small Wetlands Acquisition Program. Private landowners manage additional areas of upland and wetland primarily for wildlife. The expanded use of no-till farming and other conservation tillage systems and the inclusion of grasses and legumes in the cropping system have increased the amount of food and cover for migratory waterfowl and resident wildlife (fig. 14).

The public lands in Sheridan County provide excellent wildlife habitat. The U.S. Fish and Wildlife Service manages about 7,100 acres as waterfowl production areas and an additional 800 acres as easement refuges. The North Dakota State Game and Fish Department will manage approximately 27,000 acres of wildlife areas as they are developed by the Bureau of Reclamation. The Bureau of Reclamation is developing an additional acreage of wildlife habitat because of losses in the construction of the Garrison Diversion Irrigation Project.

Important game bird species in the county are gray partridge, ring-necked pheasant, ducks, geese, mourning dove, grouse, and sandhill crane. The mammals that are hunted in the county include red fox, coyote, white-tailed deer, muskrat, mink, raccoon, badger, cottontail rabbit, and white-tailed jackrabbit.

A variety of fish species inhabit the waters in the county. Northern pike, walleye, yellow perch, largemouth bass, bluegill, muskellunge, and crappie are the major species. Most of the fish are in public lakes and in the McClusky Canal. The potential for developing additional fishery resources is limited.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

Figure 14.—An area of dense nesting cover for a gray partridge.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate wheatgrass, tall wheatgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, buffaloberry, snowberry, and juneberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, saltgrass, prairie cordgrass, bulrush, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include gray partridge, pheasant, meadowlark, lark bunting, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, deer, sharp-tailed grouse, western meadowlark, sparrow, and grasshopper.

About 87,500 acres in Sheridan County, or nearly 14 percent the total acreage, meets the requirements for hydric soils. The map units in the survey area that display hydric characteristics are listed in this section. Areas that have been artificially drained or otherwise so altered that they no longer support a predominance of hydrophytic vegetation are not identified as hydric soils on the soil maps. The list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location of each is shown on the detailed maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

2	Marysland loam
6	Harriet silt loam
7	Fossum loamy sand
10	Southam silty clay loam
11	Parnell silt loam
12	Parnell-Vallers complex, 0 to 3 percent slopes
18	Fram and Vallers loams, saline, 0 to 3 percent slopes (Vallers part)
19	Tonka silt loam
23	Marysland silt loam, channeled
32C	Barnes-Buse-Parnell complex, 0 to 9 percent slopes (Parnell part)
32F	Barnes-Buse-Parnell complex, 0 to 35 percent slopes (Parnell part)
57	Hamerly-Tonka complex, 0 to 3 percent slopes (Tonka part)
75	Fram-Tonka complex, 0 to 3 percent slopes (Tonka part)
99C	Williams-Zahl-Parnell complex, 0 to 9 percent slopes (Parnell part)
99F	Zahl-Williams-Parnell complex, 0 to 35 percent slopes (Parnell part)

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils *may be included within the mapped areas of a specific soil.*

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and ills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, find sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 422 (ASTM), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 4318 (ASTM); Plasticity index—T 90 (AASHTO), D 4318 (ASTM); and Moisture density—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(17)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has a udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(15)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(17)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arvilla Series

The Arvilla series consists of very deep, somewhat excessively drained soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 25 percent.

Typical pedon of Arvilla sandy loam, 0 to 6 percent slopes, 1,315 feet north and 485 feet west of the southeast corner of sec. 33, T. 150 N., R. 74 W.

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; few very fine pores; neutral; abrupt smooth boundary.

Bw1—7 to 14 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; neutral; clear wavy boundary.

Bw2—14 to 17 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; few fine irregularly shaped masses of lime; slight effervescence; slightly alkaline; clear wavy boundary.

2C1—17 to 27 inches; brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; lime coatings on the underside of pebbles in the upper part; strong effervescence; slightly alkaline; gradual wavy boundary.

2C2—27 to 60 inches; olive brown (2.5Y 4/4) gravelly coarse sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; nonsticky and nonplastic; about 20 percent gravel; slight effervescence; slightly alkaline.

The depth to sand or gravel ranges from 14 to 25 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 4. The 2C horizon is sand, gravelly coarse sand, coarse sand, or gravelly loamy sand. The content of gravel in this horizon ranges from 5 to 35 percent.

Barnes Series

The Barnes series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Barnes loam, in an area of Buse-Barnes loams, 15 to 35 percent slopes, 5 feet south and 55 feet east of the northwest corner of sec. 25, T. 149 N., R. 76 W.

A—0 to 5 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few fine and many very fine roots; few fine and very fine pores; about 2 percent gravel; neutral; clear wavy boundary.

Bw—5 to 15 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to strong medium subangular blocky; slightly hard and friable; sticky and plastic; few fine and common very fine roots; common very fine pores; about 2 percent gravel; neutral; clear wavy boundary.

Bk—15 to 23 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to strong medium subangular blocky; hard and friable; sticky and plastic; common very fine roots; common very fine pores; about 5 percent gravel; common fine irregularly shaped masses of lime; violent effervescence; slightly alkaline; gradual wavy boundary.

C—23 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard and friable; sticky and plastic; few very fine roots; few very fine pores; about 5 percent gravel; common medium irregularly shaped masses of lime; moderately alkaline; violent effervescence.

The thickness of the mollic epipedon ranges from 7 to 16 inches. Some pedons have as much as 10 percent cobbles throughout.

The A horizon has value of 2 or 3 (3 or 4 dry). It has chroma of 1 in the upper part and chroma of 1 or 2 in the lower part. The Bw, Bk, and C horizons are loam or clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 2 to 4. The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Bowbells Series

The Bowbells series consists of very deep, well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 3 to 6 percent.

The Bowbells soils in this county have a slightly lower chroma in the surface layer than is definitive for the series. This difference, however, does not alter the use and management of the soils.

Typical pedon of Bowbells loam, in an area of

Williams Bowbells loams, 3 to 6 percent slopes, 650 feet south and 2,490 feet east of the northwest corner of sec. 32, T. 146 N., R. 78 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; neutral; abrupt smooth boundary.

A—6 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard and friable; slightly sticky and slightly plastic; many very fine roots; few very fine pores; neutral; clear wavy boundary.

Bt1—8 to 12 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium and fine angular blocky; hard and friable; sticky and plastic; many very fine roots; common very fine pores; many distinct clay films on faces of peds; neutral; clear wavy boundary.

Bt2—12 to 20 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to strong fine and medium angular blocky; hard and firm; sticky and plastic; common very fine roots; few very fine pores; about 2 percent gravel; many distinct clay films on faces of peds; neutral; gradual wavy boundary.

Bk1—20 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate coarse prismatic structure parting to moderate medium and fine subangular blocky; soft and friable; sticky and plastic; few very fine roots; common very fine pores; about 2 percent gravel; lime disseminated throughout and in common fine irregularly shaped masses; strong effervescence; moderately alkaline; clear wavy boundary.

Bk2—24 to 30 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak coarse prismatic structure parting to weak fine and medium subangular blocky; soft and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 5 percent gravel; common medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—30 to 48 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; massive; soft and friable; slightly sticky and slightly plastic; few very fine roots; few very fine pores; about 5 percent gravel; few fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—48 to 60 inches; olive brown (2.5Y 4/4) clay loam, light brownish gray (2.5Y 6/2) dry; few medium prominent dark reddish brown (5YR 3/4) mottles; massive; hard and friable; sticky and plastic; about 10 percent gravel; moderately alkaline; slight effervescence.

The thickness of the mollic epipedon ranges from 16 to more than 20 inches. The depth to carbonates ranges from 18 to more than 40 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). The Bt horizon has chroma of 2 or 3. The Bk horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 or 3. It is loam or clay loam. The C horizon has value of 3 to 5 (4 to 7 dry).

Buse Series

The Buse series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 35 percent.

Typical pedon of Buse loam, in an area of Buse-Barnes loams, 15 to 35 percent slopes, 165 feet north and 60 feet east of the southwest corner of sec. 24, T. 149 N., R. 76 W.

A—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few fine and many very fine roots; few very fine pores; about 2 percent gravel; slightly alkaline; clear smooth boundary.

Bk—6 to 16 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) clay loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; many very fine pores; about 2 percent gravel; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

C—16 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard and firm; sticky and plastic; few very fine roots; few very fine pores; about 2 percent gravel; lime disseminated throughout and in few fine irregularly shaped masses; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bk and C horizons are loam or clay loam. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 10YR, value of 4 to 6 (4 to 7 dry), and chroma of 2 to 4.

Cathay Series

The Cathay series consists of very deep, moderately well drained, moderately slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cathay loam, in an area of Cathay-Emrick loams, 0 to 6 percent slopes, 400 feet south and 230 feet east of the northwest corner of sec. 23, T. 149 N., R. 74 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; slightly acid; abrupt smooth boundary.

Btn1—7 to 15 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; few fine and many very fine pores; few faint clay films on faces of peds and lining pores; light gray (10YR 7/2 dry) uncoated silt and sand grains on faces and tops of peds; neutral; clear wavy boundary.

Btn2—15 to 22 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; many very fine pores; few faint clay films on faces of peds; slightly alkaline; clear wavy boundary.

Bk1—22 to 34 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard and friable; slightly sticky and slightly plastic; few very fine roots; many very fine pores; about 2 percent gravel; many fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—34 to 46 inches; light yellowish brown (2.5Y 6/4) loam, pale yellow (2.5Y 7/4) dry; moderate coarse subangular blocky structure; hard and friable; slightly sticky and slightly plastic; few very fine roots; many very fine pores; about 2 percent gravel; common medium irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—46 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; lime disseminated throughout and in few fine irregularly shaped masses; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 22 inches. The A horizon has value of 2 or 3 (3 or 4 dry). Some pedons have an E horizon, which is as much as 4 inches thick. The Btn horizon has hue of 10YR or 2.5Y and chroma of 1 to 3. It is loam or clay loam. The Bk horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. The C horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4.

Cavour Series

The Cavour series consists of very deep, moderately well drained, very slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cavour loam, in an area of Cresbard-Cavour loams, 0 to 6 percent slopes, 1,750 feet north and 780 feet east of the southwest corner of sec. 10, T. 146 N., R. 75 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; common medium and coarse and many fine and very fine roots; neutral; abrupt wavy boundary.

E—7 to 8 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium platy structure; slightly hard and friable; slightly sticky and slightly plastic; common medium and coarse and many fine and very fine roots; many fine and very fine pores; neutral; abrupt irregular boundary.

Btn—8 to 19 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong very coarse columnar structure parting to strong medium and fine angular blocky; hard and very firm; very sticky and very plastic; few medium and common coarse roots along the top of columns and on faces of peds; common very fine pores; common distinct clay films on faces of peds and lining pores; moderately alkaline; abrupt wavy boundary.

Btknz—19 to 29 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong coarse prismatic structure parting to moderate medium and fine angular blocky; hard and very firm; very sticky and very plastic; few fine and many very fine roots; many fine and very fine pores; common distinct clay films on faces of peds and lining pores; common fine salt crystals; lime segregated in common fine irregularly shaped masses; strong effervescence; moderately alkaline; clear wavy boundary.

Bkyz1—29 to 39 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; strong coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; very sticky and very plastic; few very fine roots; many very fine pores; common fine salt crystals; many fine masses of gypsum crystals; lime segregated in many fine and medium irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkyz2—39 to 46 inches; grayish brown (2.5Y 5/2) silty clay, light gray (2.5Y 7/2) dry; common medium prominent dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure parting to moderate medium subangular blocky; slightly hard and firm; sticky and plastic; few fine salt crystals; few fine masses of gypsum crystals; lime disseminated throughout and in many fine and medium irregularly shaped masses; violent effervescence; strongly alkaline; gradual wavy boundary.

C1—46 to 54 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; many fine prominent yellowish brown (10YR 5/8) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; few fine salt crystals; common fine masses of gypsum crystals; lime segregated in common fine filaments and irregularly shaped masses; violent effervescence; strongly alkaline; gradual wavy boundary.

C2—54 to 60 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; common fine prominent yellowish brown (10YR 5/6 and 5/8) mottles; massive; hard and friable; slightly sticky and slightly plastic; few fine salt crystals; common fine masses of gypsum crystals; lime segregated in common fine filaments and medium irregularly shaped masses; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 30 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The E horizon has value of 2 to 5 (3 to 7 dry) and chroma of 1 or 2. It is silt loam or loam. The Btn and Bkyz horizons are silty clay, silty clay loam, or clay loam. The Btn horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The Bkyz horizon has chroma of 1 to 3. The C horizon has chroma of 1 to 4. It is loam or clay loam.

Cresbard Series

The Cresbard series consists of very deep, moderately well drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cresbard loam, in an area of Barnes-Cresbard loams, 1 to 6 percent slopes, 2,100 feet south and 110 feet west of the northeast corner of sec. 14, T. 147 N., R. 74 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few fine and common very fine roots; neutral; abrupt smooth boundary.

B/E—6 to 13 inches; very dark grayish brown (10YR 3/2) clay loam (B), dark grayish brown (10YR 4/2) dry; dark grayish brown (10YR 4/2) E material, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; few fine and common very fine pores; few gray (10YR 5/1 dry) silt coatings on faces of peds; slightly acid; clear wavy boundary.

Btn1—13 to 22 inches; brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; moderate coarse prismatic structure parting to moderate medium angular blocky; hard and friable; sticky and plastic; few very fine roots; few fine and common very fine pores; common distinct clay films on faces of peds; uncoated sand grains on faces of peds; about 2 percent gravel; slightly acid; clear wavy boundary.

Btn2—22 to 27 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard and friable; sticky and plastic; few very fine roots; common very fine pores; common distinct clay films on faces of peds and lining pores; about 2 percent gravel; slightly alkaline; gradual wavy boundary.

Bk1—27 to 35 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard and friable; sticky and plastic; few very fine roots; common very fine pores; about 2 percent gravel; common fine irregularly shaped masses and seams of lime; violent effervescence; slightly alkaline; gradual wavy boundary.

Bk2—35 to 44 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard and friable; sticky and plastic; few very fine roots; common very fine pores; about 2 percent gravel; few fine salt crystals; few fine masses of gypsum crystals; common medium irregularly shaped masses and fine seams of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—44 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; common fine prominent gray (N 5/0) mottles; massive; hard and friable; sticky and plastic; few very fine pores; about 2 percent gravel; common fine salt crystals; common fine masses of gypsum crystals; few fine and common large irregularly shaped masses of lime; violent effervescence; strongly alkaline.

The thickness of the mollic epipedon ranges from 7 to 22 inches. The A horizon has value of 2 or 3 (3 or 4 dry). Some pedons have an E horizon, which is 1 to 2 inches thick. The B/E horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 or 2. It is clay loam or silty clay loam. The Btn horizon has value of 2 to 4 (3 to 6 dry) and chroma of 1 to 3. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is clay loam or loam.

Divide Series

The Divide series consists of very deep, somewhat poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Divide loam, 0 to 3 percent slopes, 2,120 feet south and 1,120 feet west of the northeast corner of sec. 13, T. 150 N., R. 74 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak coarse granular structure; hard and very friable; slightly sticky and slightly plastic; few fine and common very fine roots; few very fine pores; about 5 percent gravel; lime segregated in few fine irregularly shaped masses; slight effervescence; moderately alkaline; abrupt smooth boundary.

ABk—8 to 15 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak coarse subangular blocky structure; hard and very friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 5 percent gravel; lime disseminated throughout and in common fine irregularly shaped masses; violent effervescence; moderately alkaline; abrupt wavy boundary.

Bk1—15 to 25 inches; dark gray (10YR 4/1) loam, gray (10YR 5/1) dry; weak coarse subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; few very fine pores; about 5 percent gravel; lime disseminated throughout and in common fine irregularly shaped masses; violent effervescence; moderately alkaline; abrupt wavy boundary.

2Bk2—25 to 30 inches; light olive brown (2.5Y 5/4) sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure; soft and friable; nonsticky and nonplastic; few very fine roots; few very fine pores; about 10 percent gravel; lime disseminated throughout and coating the underside of pebbles; strong effervescence; moderately alkaline; clear wavy boundary.

2C—30 to 60 inches; light olive brown (2.5Y 5/4) gravelly loamy sand, pale yellow (2.5Y 7/4) dry; single grain; loose; nonsticky and nonplastic; about 20 percent gravel; lime coatings on the underside of pebbles; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). Some pedons do not have an ABk horizon. The Bk1 horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 to 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Emrick Series

The Emrick series consists of very deep, moderately well drained, moderately permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Emrick loam, in an area of Heimdal-Emrick loams, 0 to 3 percent slopes, 2,430 feet south and 1,400 feet east of the northwest corner of sec. 13, T. 148 N., R. 76 W.

A—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium and coarse granular structure; slightly hard and friable; slightly sticky and slightly plastic; few fine and many very fine roots; few very fine pores; neutral; clear smooth boundary.

Bw1—8 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; few fine and common very fine pores; about 2 percent gravel; neutral; clear wavy boundary.

Bw2—17 to 22 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; slightly alkaline; gradual irregular boundary.

Bk1—22 to 35 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—35 to 44 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—44 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; few fine irregularly shaped masses of lime; moderately alkaline; violent effervescence.

The thickness of the mollic epipedon ranges from 16 to 36 inches. The A horizon has value of 2 or 3 (3 or 4 dry). It has chroma of 1 in the upper part and chroma of 1 or 2 in the lower part. The Bw horizon has hue of 10YR or 2.5Y and value of 3 or 4. The Bk horizon has value of 4 or 5 (5 to 7 dry). The C horizon is loam or sandy loam.

Esmond Series

The Esmond series consists of very deep, well drained, moderately permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 6 to 35 percent.

Typical pedon of Esmond loam, in an area of Esmond-Heimdal loams, 15 to 35 percent slopes, 1,695 feet north and 10 feet east of the southwest corner of sec. 15, T. 148 N., R. 75 W.

A—0 to 4 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common fine and many very fine roots; few fine and common very fine pores; about 1 percent gravel; slightly alkaline; clear wavy boundary.

AB—4 to 9 inches; dark grayish brown (10YR 4/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to moderate medium granular; slightly hard and friable; slightly sticky and slightly plastic; few fine and common very fine roots; few fine and common very fine pores; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

Bk1—9 to 16 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few fine and common very fine roots; few fine and common very fine pores; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—16 to 26 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; massive; hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—26 to 43 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; massive; hard and friable; slightly sticky and slightly plastic; few very fine roots; few very fine pores; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—43 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and very friable; slightly sticky and slightly plastic; few fine irregularly shaped masses of lime; slight effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The C horizon is loam, fine sandy loam, or sandy loam.

Fossum Series

The Fossum series consists of very deep, poorly drained, rapidly permeable, calcareous soils on lake plains and outwash plains. These soils formed in glaciolacustrine and glaciofluvial deposits. Slope is 0 to 1 percent.

The Fossum soils in this county are taxadjuncts because they are characterized by an irregular decrease in content of organic matter with increasing depth. This difference, however, does not alter the use and management of the soils.

Typical pedon of Fossum loamy sand, 1,910 feet south and 1,030 feet west of the northeast corner of sec. 5, T. 150 N., R. 75 W.

A1—0 to 17 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak medium and fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; common medium and coarse and many fine and very fine roots; slight effervescence; slightly alkaline; gradual wavy boundary.

A2—17 to 24 inches; very dark grayish brown (10YR 3/2) loamy sand, gray (10YR 5/1) dry; common fine distinct light brownish gray (10YR 6/2) and common medium prominent olive brown (2.5Y 4/4) mottles; weak medium and fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; few coarse and common fine and very fine roots; few coarse and common very fine pores; slight effervescence; slightly alkaline; gradual wavy boundary.

C—24 to 34 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; common medium distinct olive brown (2.5Y 4/4) and common fine distinct light brownish gray (10YR 6/2) mottles; single grain; soft and very friable; nonsticky and nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

Ab—34 to 40 inches; very dark grayish brown (2.5Y 3/2) loamy fine sand, gray (N 5/0) dry; single grain; soft and very friable; nonsticky and nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

C′—40 to 60 inches; olive (5Y 5/3) loamy sand, pale olive (5Y 6/3) dry; common fine prominent yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; single grain; slightly hard and very friable; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3. The A2 and C horizons are loamy sand, loamy fine sand, or fine sand. The C horizon has value of 3 to 6 and chroma of 1 to 3.

Fram Series

The Fram series consists of very deep, somewhat poorly drained, moderately permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Fram loam, in an area of Fram-Tonka complex, 0 to 3 percent slopes, 1,600 feet north and 165 feet west of the southeast corner of sec. 23, T. 148 N., R. 75 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—7 to 17 inches; light yellowish brown (2.5Y 6/4) loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; lime disseminated throughout and in many fine irregularly shaped masses; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—17 to 31 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; lime disseminated throughout and in common fine irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—31 to 38 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; massive; soft and very friable; slightly sticky and slightly plastic; few very fine roots; few very fine pores; about 2 percent gravel; lime disseminated throughout and in few fine irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—38 to 60 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; few fine prominent gray (N 6/0) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; few very fine pores; about 2 percent gravel; lime disseminated throughout and in few fine irregularly shaped masses; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The soils are nonsaline to moderately saline.

The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y and value of 4 to 6 (5 to 7 dry). It is loam or fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. It is loam, sandy loam, or fine sandy loam.

Hamerly Series

The Hamerly series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Hamerly loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes, 2,030 feet south and 1,110 feet east of the northwest corner of sec. 31, T. 147 N., R. 74 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; common very fine and few fine roots; about 2 percent gravel; common fine irregularly shaped masses of lime; strong effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—7 to 17 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; moderate coarse subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few fine and common very fine roots; common very fine pores; about 2 percent gravel; lime disseminated throughout and in many fine and medium irregularly shaped masses; violent effervescence; slightly alkaline; clear wavy boundary.

Bk2—17 to 28 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; many very fine pores; about 3 percent gravel; lime disseminated throughout and in many fine irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—28 to 36 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent gray (10YR 5/1) and strong brown (7.5YR 5/8) mottles; massive; slightly hard and friable; sticky and plastic; many very fine pores; about 5 percent gravel; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—36 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent gray (10YR 5/1) and strong brown (7.5YR 5/8) mottles; massive; hard and friable; sticky and plastic; many very fine pores; about 10 percent gravel; common fine irregularly shaped masses of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. Some pedons have an ABk horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 7 dry, and chroma of 1 to 4. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Harriet Series

The Harriet series consists of very deep, poorly drained, slowly permeable, sodic, saline soils on terraces and flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Harriet silt loam, 1,210 feet north and 215 feet west of the southeast corner of sec. 3, T. 150 N., R. 77 W.

E—0 to 1 inch; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak medium platy structure; soft and friable; slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; neutral; abrupt smooth boundary.

Btnz—1 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate coarse columnar structure; slightly hard and firm; sticky and plastic; common fine and very fine roots; few fine and very fine pores; common distinct clay films on faces of peds; very dark gray (10YR 3/1) silt coatings on the top and sides of columns; common fine threads of salt crystals; moderately alkaline; gradual irregular boundary.

Bkz1—9 to 24 inches; grayish brown (2.5Y 5/2) clay loam, light gray (5Y 6/1) dry; common fine and medium distinct gray (5Y 5/1) mottles; weak coarse subangular blocky structure; hard and friable; sticky and plastic; few very fine roots; many very fine pores; common fine salt crystals; lime disseminated throughout and in common fine irregularly shaped masses; strong effervescence; strongly alkaline; gradual wavy boundary.

Bkz2—24 to 42 inches; gray (5Y 5/1) and olive gray (5Y 5/2) silty clay loam, light olive gray (5Y 6/2) dry; many fine prominent light olive brown (2.5Y 5/6) mottles; weak coarse subangular blocky structure; hard and firm; sticky and plastic; common very fine pores; few fine salt crystals; lime segregated in many medium irregularly shaped masses; violent effervescence; strongly alkaline; abrupt wavy boundary.

2C1—42 to 47 inches; grayish brown (2.5Y 5/2) loamy sand, light gray (5Y 6/1) dry; many fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard and very friable; nonsticky and nonplastic; common fine and very fine pores; slight effervescence; strongly alkaline; clear wavy boundary.

2C2—47 to 55 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; single grain; soft and very friable; nonsticky and nonplastic; slight effervescence; strongly alkaline; abrupt wavy boundary.

2C3—55 to 60 inches; dark yellowish brown (10YR 4/4) gravelly loamy sand, yellowish brown (10YR 5/4) dry; single grain; soft and very friable; nonsticky and nonplastic; about 20 percent fine gravel; strong effervescence; strongly alkaline.

The E horizon has hue of 10YR or 2.5Y and value of 2 to 5 (4 to 7 dry). The Btnz horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 or 5 dry), and chroma of 1 or 2. It is silty clay loam, clay loam, or silty clay. Some pedons have a C horizon, which is as much as 20 inches thick.

Heimdal Series

The Heimdal series consists of very deep, well drained, moderately permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Heimdal loam, in an area of Heimdal-Emrick loams, 0 to 3 percent slopes, 720 feet west and 190 feet north of the southeast corner of sec. 35, T. 149 N., R. 74 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine and medium granular structure; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bw1—7 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; common very fine pores; neutral; clear wavy boundary.

Bw2—11 to 18 inches; brown (10YR 4/3) loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; common very fine pores; slightly alkaline; clear wavy boundary.

Bk—18 to 30 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; about 2 percent gravel; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; few very fine pores; about 2 percent gravel; few fine irregularly shaped masses of lime; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 5 (4 to 6 dry) and chroma of 2 to 4. The Bk horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4. It is loam or sandy loam.

Larson Series

The Larson series consists of very deep, somewhat poorly drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Larson loam, in an area of Larson-Cathay loams, 0 to 3 percent slopes, 2,620 feet south and 2,320 feet west of the northeast corner of sec. 35, T. 150 N., R. 76 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; soft and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

E—8 to 11 inches; dark gray (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/3) dry; moderate medium subangular blocky structure parting to weak thin platy; soft and very friable; nonsticky and nonplastic; few very fine roots; common very fine pores; neutral; abrupt wavy boundary.

Btn—11 to 18 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate coarse columnar structure parting to moderate medium angular blocky; hard and firm; sticky and plastic; few very fine roots on the top of columns and on faces of peds; common very fine pores; common distinct clay films on faces of peds; slightly alkaline; gradual wavy boundary.

Btny—18 to 23 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard and firm; sticky and plastic; few very fine roots; common very fine pores; common faint clay films on faces of peds and in pores; common soft filaments of gypsum;

common nests of salts; moderately alkaline; gradual wavy boundary.

By1—23 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; moderate coarse subangular blocky structure; hard and firm; sticky and plastic; few very fine roots; common very fine pores; common soft filaments and few nests of gypsum; lime disseminated throughout; slight effervescence; moderately alkaline; gradual wavy boundary.

By2—30 to 32 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; weak coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; common very fine pores; few fine nests of gypsum; lime disseminated throughout; slight effervescence; moderately alkaline; gradual wavy boundary.

Bky—32 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; massive; hard and firm; sticky and plastic; few very fine pores; few gypsum crystals; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 or 4 dry). The E horizon has value of 2 to 5 (5 to 7 dry) and chroma of 1 or 2. The Btn horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. Some pedons do not have a Btny horizon. The By and Bky horizons have hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. Some pedons have a C horizon.

Lehr Series

The Lehr series consists of very deep, somewhat excessively drained soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Lehr loam, 0 to 6 percent slopes, 650 feet south and 450 feet east of the northwest corner of sec. 20, T. 148 N., R. 78 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bw1—7 to 10 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; sticky and plastic; common very fine roots; neutral; clear wavy boundary.

Bw2—10 to 15 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; clear wavy boundary.

2C—15 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose; nonsticky and nonplastic; few very fine roots to a depth of 24 inches; about 60 percent medium gravel; lime coatings on the underside of pebbles; strong effervescence; moderately alkaline.

The depth to sand and gravel ranges from 14 to 20 inches. The A horizon has value of 2 or 3 (4 or 5 dry). The Bw horizon has value of 3 or 4 (4 to 6 dry). Some pedons have a Bk horizon, which is as much as 6 inches thick.

Maddock Series

The Maddock series consists of very deep, well drained, rapidly permeable soils on lake plains, till plains, and outwash plains. These soils formed in glaciolacustrine and glaciofluvial deposits. Slope ranges from 0 to 25 percent.

The Maddock soils in this county have a slightly higher chroma in the surface layer than is definitive for the series. This difference, however, does not alter the use and management of the soils.

Typical pedon of Maddock loamy fine sand, 0 to 6 percent slopes, 615 feet south and 2,180 feet west of the northeast corner of sec. 19, T. 150 N., R. 75 W.

A—0 to 11 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; loose; nonsticky and nonplastic; many very fine roots; few very fine pores; neutral; gradual wavy boundary.

Bw—11 to 19 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; loose; nonsticky and nonplastic; neutral; gradual wavy boundary.

C1—19 to 37 inches; olive brown (2.5Y 4/4) fine sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

C2—37 to 48 inches; olive brown (2.5Y 4/4) fine sand, pale yellow (2.5Y 7/4) dry; single grain; loose; nonsticky and nonplastic; lime disseminated throughout; slight effervescence; slightly alkaline; gradual wavy boundary.

C3—48 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; single grain; loose; nonsticky and nonplastic; common fine irregularly shaped masses of lime; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to carbonates is 10 inches or more.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The Bw horizon has value of 2 to 5 (4 to 6 dry) and chroma of 2 to 4. It is fine sand, loamy sand, or loamy fine sand. The C horizon has hue of 2.5Y or 10YR and value of 3 to 6 (4 to 7 dry).

Marysland Series

The Marysland series consists of very deep, poorly drained, highly calcareous soils on outwash plains and flood plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Marysland loam, 1,800 feet north and 1,850 feet west of the southeast corner of sec. 12, T. 148 N., R. 74 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard and friable; sticky and plastic; many very fine roots; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—9 to 15 inches; gray (10YR 6/1) loam, light gray (10YR 7/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; tongues of A horizon material about 1 inch wide; lime disseminated throughout and in common fine irregularly shaped masses; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—15 to 24 inches; gray (10YR 6/1) loam, light gray (10YR 7/1) dry; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout and in common medium irregularly shaped masses; violent effervescence; moderately alkaline; clear wavy boundary.

2C1—24 to 35 inches; grayish brown (2.5Y 5/2) gravelly sand, light brownish gray (2.5Y 6/2) dry; few medium prominent yellowish brown (10YR 5/4) mottles; single grain; loose; nonsticky and nonplastic; few very fine roots; about 30 percent gravel; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

2C2—35 to 60 inches; grayish brown (2.5Y 5/2) very gravelly coarse sand, light gray (2.5Y 7/2) dry; common medium and large prominent yellowish red (5YR 5/6) mottles; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; lime disseminated throughout; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 30 inches. Depth to the calcic horizon ranges from 6 to 16 inches.

The Ap horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (3 to 5 dry). It is loam or silt loam. Some pedons have an Ab horizon, which is as much as 5 inches thick. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 1 or 2. It is loam or clay loam. The 2C horizon has hue of 2.5Y or 5Y, value of 3 to 6 (4 to 7 dry), and chroma of 1 or 2. It is fine sand, gravelly sand, or very gravelly coarse sand. The content of gravel in this horizon ranges from about 5 to 40 percent.

Miranda Series

The Miranda series consists of very deep, somewhat poorly drained, very slowly permeable, sodic, saline soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Miranda loam, 0 to 3 percent slopes, 1,190 feet south and 750 feet east of the northwest corner of sec. 3, T. 150 N., R. 76 W.

E—0 to 1 inch; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to weak thin platy; soft and friable; slightly sticky and slightly plastic; few coarse and many fine and very fine roots; neutral; abrupt wavy boundary.

Btn—1 to 13 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; strong coarse columnar structure; very hard and very firm; very sticky and very plastic; common fine and very fine roots; few fine and very fine pores; common distinct clay films on faces of peds and in pores; gray (10YR 5/1 dry) silt coatings on the top and sides of columns; few fine threads and masses of salt crystals in the lower part; moderately alkaline; clear wavy boundary.

Btnz—13 to 21 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; strong coarse prismatic structure parting to moderate medium subangular blocky; very hard and very firm; very sticky and very plastic; many very fine roots; few very fine pores; common distinct clay films on faces of peds; common fine and medium threads and masses of salt crystals; moderately alkaline; clear wavy boundary.

Bkyz1—21 to 32 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common fine prominent yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; hard and firm; sticky and plastic; common very fine roots; few very fine pores; many fine and medium masses of salt crystals; common medium and fine masses of gypsum crystals; lime segregated in many medium and fine irregularly shaped masses; violent effervescence; strongly alkaline; abrupt wavy boundary.

Bkyz2—32 to 46 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; common medium prominent dark yellowish brown (10YR 4/4) and common medium and fine prominent yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; hard and firm; sticky and plastic; few very fine roots; few very fine pores; many medium and fine masses of salt crystals; common medium and fine masses of gypsum crystals; lime segregated in many medium and fine irregularly shaped masses; violent effervescence; strongly alkaline; gradual wavy boundary.

C1—46 to 54 inches; light olive brown (2.5Y 5/4) sandy loam, light yellowish brown (2.5Y 6/4) dry; many fine prominent yellowish brown (10YR 5/6) mottles; massive; hard and very friable; nonsticky and nonplastic; slight effervescence; strongly alkaline; gradual wavy boundary.

C2—54 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent yellowish brown (10YR 5/6) and many medium distinct grayish brown (2.5Y 5/2) mottles; massive; hard and firm; slightly sticky and slightly plastic; slight effervescence; strongly alkaline.

The E horizon has hue of 10YR or 2.5Y and value of 3 or 4 (4 to 6 dry). The Btn and Btnz horizons have hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 to 4. They are clay loam or loam. The Bkyz horizon has hue of 2.5Y or 5Y, value of 2 to 5 (3 to 6 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 3 to 7 (4 to 8 dry), and chroma of 1 to 4. It is sandy loam, loam, or clay loam.

Nutley Series

The Nutley series consists of very deep, well drained, slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Nutley silty clay, 0 to 6 percent slopes, 1,560 feet south and 360 feet east of the northwest corner of sec. 25, T. 146 N., R. 75 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; slightly hard and friable; very sticky and very plastic; many very fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bw1—7 to 22 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and friable; very sticky and very plastic; common very fine roots; common very fine pores; A horizon material extending downward in cracks one-quarter to one-half inch wide; lime segregated in few fine irregularly shaped masses; strong effervescence; moderately alkaline; gradual wavy boundary.

Bw2—22 to 37 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; weak coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and friable; very sticky and very plastic; few very fine roots; common very fine pores; A horizon material extending downward in cracks one-quarter to one-half inch wide to a depth of about 28 inches; lime segregated in common medium and fine irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—37 to 49 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; few medium prominent yellowish brown (10YR 5/8) and many medium faint very dark grayish brown (2.5Y 3/2) relict mottles; massive; slightly hard and firm; very sticky and very plastic; few very fine roots; common very fine pores; lime disseminated throughout and in few fine irregularly shaped masses; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—49 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; many medium prominent gray (N 5/0) and few medium prominent yellowish brown (10YR 5/8) relict mottles; massive; hard and firm; very sticky and very plastic; few very fine pores; lime segregated in few fine irregularly shaped masses; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR to 5Y and value of 3 to 5 (4 to 6 dry). It is silty clay or clay. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 4. It is silty clay, clay, or clay loam.

Orthents

Orthents consist of very deep, well drained, slowly permeable soils on uplands. These soils formed in disturbed glacial till. Slope ranges from 1 to 75 percent.

Reference pedon of Orthents, loamy, 1 to 75 percent slopes, 920 feet north and 590 feet east of the southwest corner of sec. 24, T. 147 N., R. 77 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; massive; very hard and friable; slightly sticky and slightly plastic; many fine and very fine roots; compacted; strong effervescence; slightly alkaline; abrupt smooth boundary.

C—3 to 60 inches; dark grayish brown (10YR 4/2) loam, grayish brown (10YR 5/2) dry; massive; very hard and friable; slightly sticky and slightly plastic; compacted; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (4 to 6 dry), and chroma of 1 or 2. The C horizon has hue of 10YR to 5Y, value of 3 to 6 (4 to 7 dry), and chroma of 1 to 4. It is loam, sandy loam, or clay loam.

Overly Series

The Overly series consists of very deep, moderately well drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Overly silty clay loam, 0 to 6 percent slopes, 2,140 feet north and 390 feet east of the southwest corner of sec. 31, T. 147 N., R. 74 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard and very friable; sticky and plastic; many very fine roots; few very fine pores; neutral; abrupt smooth boundary.

A—6 to 10 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; strong coarse granular structure; slightly hard and very friable; sticky and plastic; common very fine roots; many very fine pores; neutral; clear wavy boundary.

Bw1—10 to 23 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and very friable; sticky and plastic; common very fine roots; many very fine pores; slightly alkaline; clear wavy boundary.

Bw2—23 to 28 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard and very friable; sticky and plastic; few very fine roots; many very fine pores; slightly alkaline; clear wavy boundary.

Bk—28 to 42 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; sticky and plastic; few very fine roots; common very fine pores; lime segregated in many fine irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—42 to 57 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; many fine prominent yellowish brown (10YR 5/4) mottles; massive; hard and very friable; sticky and plastic; few very fine pores; lime segregated in common fine irregularly shaped masses; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—57 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; many fine distinct yellowish brown (10YR 5/4) mottles; massive; slightly hard and very friable; sticky and plastic; about 5 percent fine gravel; lime disseminated throughout and in few fine irregularly shaped masses; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw and Bk horizons are silty clay loam or silt loam. The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 3. The C horizon has hue of 2.5Y or 5Y and value of 4 to 6. It is silty clay loam, clay loam, or silt loam.

Parnell Series

The Parnell series consists of very deep, very poorly drained, slowly permeable soils on till plains and moraines. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Parnell silt loam, in an area of Zahl-Williams-Parnell complex, 0 to 35 percent slopes, 2,100 feet south and 550 feet west of the northeast corner of sec. 21, T. 146 N., R. 78 W.

A1—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; many fine and very fine roots; neutral; abrupt smooth boundary.

A2—7 to 13 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure; slightly hard and very friable; sticky and plastic; common very fine roots; neutral; abrupt smooth boundary.

Bt1—13 to 23 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong coarse prismatic structure parting to strong medium angular blocky; hard and friable; very sticky and very plastic; common very fine roots; common very fine pores; many distinct clay films on faces of peds; neutral; clear wavy boundary.

Bt2—23 to 37 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; strong coarse prismatic structure parting to strong medium angular blocky; hard and firm; very sticky and very plastic; common very fine roots; common very fine pores; many distinct clay films on faces of peds; neutral; clear wavy boundary.

BC—37 to 56 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard and firm; very sticky and very plastic; few very fine roots; common very fine pores; neutral; clear wavy boundary.

Cg—56 to 60 inches; dark olive gray (5Y 3/2) silty clay, olive gray (5Y 5/2) dry; common fine prominent olive brown (2.5Y 4/4) mottles; massive; hard and firm; very sticky and very plastic; few very fine pores; neutral.

The thickness of the mollic epipedon ranges from 24 to 60 inches. The A horizon has hue of 10YR to 5Y and value of 2 or 3. The Bt horizon has hue of 10YR to 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 3 to 6 (4 to 7 dry), and chroma of 1 or 2. It is silty clay loam, silty clay, or clay loam.

Renshaw Series

The Renshaw series consists of very deep, somewhat excessively drained soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Renshaw loam, 0 to 6 percent slopes, 1,910 feet north and 820 feet east of the southwest corner of sec. 25, T. 150 N., R. 74 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; common very fine pores; neutral; clear smooth boundary.

Bw1—6 to 13 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; common very fine pores; neutral; clear wavy boundary.

Bw2—13 to 15 inches; dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/4) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; common very fine pores; neutral; abrupt wavy boundary.

2C1—15 to 33 inches; dark brown (10YR 4/3) very gravelly loamy sand, brown (10YR 5/3) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; about 50 percent gravel; lime coatings on the underside of pebbles; slight effervescence; slightly alkaline; diffuse wavy boundary.

2C2—33 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly loamy sand, light yellowish brown (10YR 6/4) dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; strong effervescence; slightly alkaline.

The depth to sand and gravel ranges from 14 to 20 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 to 5 dry and chroma of 1 to 4. The 2C horizon is very gravelly loamy sand, gravelly loamy sand, gravelly coarse sand, or very gravelly coarse sand. The content of gravel in this horizon ranges from 20 to 55 percent.

Sioux Series

The Sioux series consists of very deep, excessively drained, rapidly permeable soils on outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 1 to 35 percent.

Typical pedon of Sioux loam, in an area of Sioux-Arvilla complex, 1 to 9 percent slopes, 755 feet south and 2,090 feet west of the northeast corner of sec. 35, T. 150 N., R. 74 W.

A—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft and very friable; slightly sticky and slightly plastic; many very fine roots; few very fine pores; about 5 percent gravel; slightly alkaline; clear smooth boundary.

AC—6 to 12 inches; very dark grayish brown (10YR 3/2) gravelly loamy sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; loose; nonsticky and nonplastic; many very fine roots; about 20 percent gravel; about 5 percent cobbles 3 to 5 inches in diameter; slight effervescence; slightly alkaline; clear wavy boundary.

C1—12 to 26 inches; dark yellowish brown (10YR 4/4) very gravelly sand, light yellowish brown (10YR 6/4) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; about 40 percent gravel; about 5 percent cobbles 3 to 5 inches in diameter; lime coatings on the underside of cobbles and pebbles; strong effervescence; moderately alkaline; clear wavy boundary.

C2—26 to 60 inches; olive brown (2.5Y 4/4) very gravelly sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; nonsticky and nonplastic; about 45 percent gravel; strong effervescence; moderately alkaline.

The depth to sand and gravel ranges from 6 to 14 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The AC horizon has value of 3 or 4 (4 to 6 dry) and chroma of 2 or 3. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. The content of gravel in this horizon ranges from 35 to 60 percent.

Southam Series

The Southam series consists of very deep, very poorly drained, slowly permeable, calcareous soils on till plains, moraines, and lake plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Southam silty clay loam, 580 feet south and 2,320 feet west of the northeast corner of sec. 27, T. 148 N., R. 76 W.

Ag1—0 to 6 inches; black (5Y 2.5/1) silty clay loam, very dark gray (5Y 3/1) dry; common fine prominent dark reddish brown (5YR 3/4) mottles; moderate fine granular structure; hard and firm; very sticky and very plastic; many fine, medium, and coarse roots; common fine and coarse pores; common fine snail shell fragments; few fine irregularly shaped masses of lime; strong effervescence; slightly alkaline; clear wavy boundary.

Ag2—6 to 25 inches; black (5Y 2.5/1) silty clay, dark gray (5Y 4/1) dry; common fine prominent dark reddish brown (5YR 3/4) mottles; moderate fine granular structure; hard and firm; very sticky and very plastic; common very fine, fine, and medium roots; common very fine and fine pores; common fine snail shell fragments; common fine irregularly shaped masses of lime; strong effervescence; slightly alkaline; gradual wavy boundary.

Cg—25 to 60 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; few fine prominent olive brown (2.5Y 4/4) mottles; massive; hard and firm; very sticky and very plastic; few very fine roots; few very fine pores; few fine snail shell fragments; lime disseminated throughout; violent effervescence; moderately alkaline.

The depth to carbonates ranges from 0 to 10 inches. The A and Cg horizons have hue of 10YR to 5Y or are neutral in hue. Some pedons have an O horizon, which is as much as 4 inches thick.

Svea Series

The Svea series consists of very deep, moderately well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Svea loam, in an area of Barnes-Svea loams, 3 to 6 percent slopes, 150 feet north and 50 feet west of the southeast corner of sec. 29, T. 150 N., R. 76 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bw1—8 to 17 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; clear wavy boundary.

Bw2—17 to 26 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak coarse and medium prismatic structure parting to moderate medium subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; fine masses of gypsum crystals in the lower part; slightly alkaline; gradual wavy boundary.

Bk—26 to 47 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak coarse and medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; sticky and plastic; common very fine roots; about 2 percent gravel; common fine irregularly shaped threads of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

BCk—47 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak coarse and medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; sticky and plastic; few very fine roots; about 2 percent gravel; few medium irregularly shaped masses of lime; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to more than 25 inches. The depth to carbonates ranges from 18 to more than 40 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). The Bw and Bk horizons are loam or clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. Some pedons do not have a BCk horizon. Some have a C horizon, which is 5 to 36 inches thick.

Swenoda Series

The Swenoda series consists of very deep, well drained soils on till plains and lake plains. These soils formed in eolian material and in glaciolacustrine deposits or glacial till. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Swenoda sandy loam, 0 to 6 percent slopes, 2,600 feet east and 2,600 feet south of the northwest corner of sec. 17, T. 150 N., R. 77 W.

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

A—7 to 12 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; clear wavy boundary.

Bw1—12 to 18 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; gradual wavy boundary.

Bw2—18 to 31 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard and very friable; slightly sticky and slightly plastic; few very fine roots; neutral; clear wavy boundary.

2Bw3—31 to 40 inches; dark brown (10YR 3/3) clay loam, light yellowish brown (2.5Y 6/4) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard and friable; sticky and plastic; few very fine roots; few fine irregularly shaped masses of lime; slightly alkaline; clear wavy boundary.

2Bk—40 to 51 inches; olive brown (2.5Y 4/4) clay loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure; very hard and friable; sticky and plastic; few very fine roots; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

2C—51 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light brownish gray (2.5Y 6/2) dry; massive; very hard and firm; sticky and plastic; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline.

Depth to the 2Bw3 or 2C horizon ranges from 20 to 40 inches. The A horizon has value of 2 or 3. It has chroma of 1 in the upper part and chroma of 1 or 2 in the lower part. The Bw horizon has value of 2 to 4 (3 to 6 dry) and chroma of 1 to 3. It is dominantly sandy loam or fine sandy loam, but in some pedons the lower part of the horizon has a layer of loamy sand 1 to 5 inches thick. Some pedons do not have a 2Bw horizon. The 2Bk horizon has hue of 2.5Y or 5Y and value of 4 to 6 (6 to 8 dry). It is silt loam, clay loam, or silty clay loam. The 2C horizon is silty clay loam, silt loam, loam, or clay loam.

Tonka Series

The Tonka series consists of very deep, poorly drained, slowly permeable soils on till plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Tonka silt loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes, 1,540 feet north and 2,380 feet east of the southwest corner of sec. 31, T. 147 N., R. 74 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; common fine and many very fine roots; few very fine pores; neutral; abrupt smooth boundary.

A—6 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few fine and common very fine roots; few very fine pores; neutral; abrupt irregular boundary.

E—11 to 21 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate thin platy structure;

soft and friable; slightly sticky and slightly plastic; common very fine roots; many very fine pores; neutral; gradual wavy boundary.

Bt—21 to 41 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; few medium prominent dark yellowish brown (10YR 4/4) mottles; moderate medium prismatic structure parting to moderate medium and fine angular blocky; very hard and firm; sticky and plastic; few very fine roots; many very fine pores; continuous distinct clay films on faces of peds; uncoated sand grains on faces of peds; neutral; gradual wavy boundary.

BC—41 to 49 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; common fine distinct dark gray (5Y 4/1) and olive brown (2.5Y 4/4) mottles; weak coarse subangular blocky structure; very hard and firm; sticky and plastic; few very fine roots; common very fine pores; lime segregated in few fine irregularly shaped masses; slight effervescence; slightly alkaline; gradual wavy boundary.

Cg—49 to 60 inches; olive (5Y 4/3) clay loam, pale olive (5Y 6/3) dry; common fine prominent yellowish brown (10YR 5/6) mottles; massive; very hard and firm; sticky and plastic; few very fine pores; lime disseminated throughout and in common medium irregularly shaped masses; strong effervescence; moderately alkaline.

The depth to carbonates ranges from 24 to more than 60 inches. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 to 2. The E horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has hue of 2.5Y or 10YR, value of 2 to 4 (3 to 6 dry), and chroma of 1 or 2. It is clay loam, silty clay loam, or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 2 to 5 (3 to 7 dry), and chroma of 1 to 4. It is silty clay loam, clay loam, or loam.

Towner Series

The Towner series consists of very deep, well drained soils on lake plains and till plains. These soils formed in eolian material and in glacial till or glaciolacustrine deposits. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 15 percent.

Typical pedon of Towner loamy fine sand, 0 to 6 percent slopes, 175 feet south and 435 feet east of the northwest corner of sec. 5, T. 150 N., R. 75 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and loose; nonsticky and nonplastic; few very fine roots; neutral; abrupt smooth boundary.

A—8 to 18 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and loose; nonsticky and nonplastic; few very fine roots; slightly alkaline; clear wavy boundary.

Bw1—18 to 26 inches; dark brown (10YR 3/3) loamy sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft and loose; nonsticky and nonplastic; few very fine roots; few very fine pores; slightly alkaline; clear wavy boundary.

Bw2—26 to 30 inches; brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft and loose; nonsticky and nonplastic; few very fine roots; few very fine pores; slightly alkaline; abrupt wavy boundary.

2Bw3—30 to 41 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; moderate medium subangular blocky structure; hard and firm; sticky and plastic; few very fine roots; few very fine pores; slightly alkaline; gradual wavy boundary.

2C—41 to 60 inches; olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) and pale yellow (2.5Y 7/4) dry; massive; hard and firm; sticky and plastic; few very fine roots; few very fine pores; few fine irregularly shaped masses of lime; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. Depth to the 2Bw horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). It has chroma of 1 in the upper part and chroma of 1 or 2 in the lower part. The Bw and 2Bw horizons have hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 1 to 4. The Bw horizon is loamy sand, fine sand, or loamy fine sand. The 2Bw and 2C horizons are silty clay loam, silt loam, or clay loam. The 2C horizon has hue of 2.5Y or 10YR, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4.

Vallers Series

The Vallers series consists of very deep, poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Vallers loam, in an area of Parnell-Vallers complex, 0 to 3 percent slopes, 1,940 feet north and 1,720 feet west of the southeast corner of sec. 1, T. 147 N., R. 75 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; many fine and few very fine, medium, and coarse roots; common very fine and fine pores; about 5 percent gravel; common fine irregularly shaped masses of lime; slight effervescence; moderately alkaline; abrupt wavy boundary.

ABk—7 to 11 inches; very dark grayish brown (10YR 3/2) and light gray (10YR 7/1) loam, gray (10YR 5/1) and white (10YR 8/1) dry; weak medium subangular blocky structure; slightly hard and very friable; sticky and plastic; common fine and very fine roots; common fine and very fine pores; about 5 percent gravel; lime disseminated throughout and in common medium irregularly shaped masses; violent effervescence; moderately alkaline; clear wavy boundary.

Bk1—11 to 16 inches; very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) silty clay loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; weak medium and coarse subangular blocky structure; slightly hard and friable; sticky and plastic; few fine and very fine roots; few fine and very fine pores; about 5 percent gravel; lime disseminated throughout and in many medium irregularly shaped masses; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—16 to 20 inches; light brownish gray (2.5Y 6/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; slightly hard and friable; sticky and plastic; few very fine roots; about 5 percent gravel; lime disseminated throughout and in many medium irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C—20 to 31 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; common fine prominent gray (N 6/0) and distinct light olive brown (2.5Y 5/6) mottles; massive; slightly hard and friable; sticky and plastic; about 5 percent gravel; lime disseminated throughout and in few fine irregularly shaped masses; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—31 to 60 inches; olive gray (5Y 4/2) clay loam, pale olive (5Y 6/3) dry; many fine and medium prominent gray (N 6/0) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard and firm; sticky and plastic; about 5 percent gravel; lime disseminated throughout and in few fine threads; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 22 inches. The soils are nonsaline to moderately saline.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 (3 to 5 dry). The Bk horizon has value of 3 to 7 dry and chroma of 1 or 2. It is silty clay loam, clay loam, or loam. The C horizon has value of 4 to 7 and chroma of 1 to 3. It is clay loam or loam.

Wabek Series

The Wabek series consists of very deep, excessively drained, very rapidly permeable soils on outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 1 to 35 percent.

Typical pedon of Wabek sandy loam, 9 to 35 percent slopes, 1,880 feet south and 650 feet east of the northwest corner of sec. 34, T. 145 N., R. 75 W.

A—0 to 7 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; many fine and very fine roots; few very fine pores; about 5 percent gravel; slightly alkaline; abrupt smooth boundary.

AC—7 to 12 inches; dark brown (10YR 3/3) gravelly loamy sand, brown (10YR 5/3) dry; single grain; loose; nonsticky and nonplastic; few very fine and fine roots; about 20 percent gravel; slightly alkaline; clear wavy boundary.

C1—12 to 18 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

C2—18 to 60 inches; olive brown (2.5Y 4/4) very gravelly coarse sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; slight effervescence; moderately alkaline.

The depth to sand and gravel ranges from 7 to 14 inches. The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 2 or 3. The content of gravel in the C horizon ranges from 35 to 60 percent.

Williams Series

The Williams series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 1 to 35 percent.

Typical pedon of Williams loam, in an area of Williams-Bowbells loams, 3 to 6 percent slopes, 2,630 feet east and 600 feet south of the northwest corner of sec. 32, T. 146 N., R. 78 W.

A—0 to 6 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium granular structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bt—6 to 15 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to strong fine and medium angular blocky; hard and friable; sticky and plastic; common very fine roots; continuous distinct clay films on faces of peds; neutral; clear wavy boundary.

Bk—15 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; sticky and plastic; common very fine roots; about 2 percent gravel; many medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C1—28 to 32 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard and friable; sticky and plastic; few very fine roots; about 2 percent gravel; few medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C2—32 to 38 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard and very friable; sticky and plastic; about 2 percent gravel; common large irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C3—38 to 60 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; massive; slightly hard and very friable; sticky and plastic; about 2 percent gravel; few fine irregularly shaped masses of lime; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The depth to carbonates ranges from 10 to 22 inches.

The Bt horizon has value of 2 to 5 (4 or 5 dry) and chroma of 2 or 3. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 6 dry), and chroma of 2 to 4. The C horizon has value of 4 to 6 (5 to 8 dry).

Zahl Series

The Zahl series consists of very deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 35 percent.

Typical pedon of Zahl loam, in an area of Zahl-Williams loams, 9 to 15 percent slopes, 620 feet south and 1,080 feet west of the northeast corner of sec. 34, T. 146 N., R. 78 W.

A—0 to 5 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure parting to moderate medium granular; soft and very friable; slightly sticky and slightly plastic; few fine and many very fine roots; about 3 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

Bk—5 to 16 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) loam, grayish brown (2.5Y 5/2) and light gray (2.5Y 7/2) dry; weak medium and coarse prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few fine and many very fine roots; about 5 percent gravel; many fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—16 to 60 inches; olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) clay loam, light olive brown (2.5Y 5/4) and light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and friable; sticky and plastic; few very fine roots; about 10 percent gravel; common medium irregularly shaped masses of lime; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk and C horizons are loam or clay loam. The Bk horizon has hue of 10YR to 5Y and value of 3 to 7 (5 to 8 dry). The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4.

Formation of the Soils

The formation of soils is a dynamic process. Soil is the product of five major soil-forming factors—the physical and mineralogical composition of the parent material, the climate under which the soil formed, the plant and animal life on and in the soil, the relief, and the length of that time these factors have acted on the soil material.

Climate, plants, and, to a lesser degree, animal life are the active factors of soil formation. They act on the parent material, slowly transforming it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief and by the parent material. Time is required for the climatic and biological forces to change the parent material into a soil.

The factors of soil formation are so closely interrelated in their effects on the soil that few general statements can be made about the effect of any one factor unless conditions are specified for the other four.

Parent Material

The soils in Sheridan County formed mainly in glacial material derived from preglacial rock. As the glaciers advanced, they picked up this rock, ground and mixed it, and transported it many miles from its place of origin. Glacial till is the unsorted material that was deposited directly by the glaciers. Barnes and Williams soils formed in glacial till.

As the glaciers melted and receded, some glacial material was washed and sorted by meltwater and by large amounts of rainfall to form glacial outwash. Arvilla and Renshaw soils formed in glaciofluvial deposits.

Glacial lakes formed in some areas of the county. Well sorted glaciolacustrine sediments were deposited by the quiet waters in these glacial lakes. Nutley and Overly soils formed in the glaciolacustrine deposits.

Some of the material was sorted by the wind. Swenoda and Towner soils formed, at least in part, in windblown glaciofluvial deposits.

Alluvium was deposited on the flood plains along streams during periods of flooding. Harriet soils formed in alluvium.

Climate

Climate has direct and indirect effects on the formation of soils. Precipitation, temperature, and wind directly affect the weathering and reworking of parent material. Climate indirectly affects soil formation through its effects on the amount and kind of vegetation and animal life on or in the soil.

Sheridan County has a dry, subhumid or semiarid climate that is characterized by long, cold winters and short, warm summers. The precipitation falls mainly during the growing season but is at times erratic. This type of climate favors the mechanical processes of weathering, such as freezing and thawing, which decrease particle size but result in little change in chemical composition.

In addition to weathering the parent material, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

Plant and Animal Life

The soils in Sheridan County formed mainly under mid and tall prairie grasses. The fibrous roots of grasses penetrate the soil to a depth of several feet, making it more porous and more granular. As a result, more water enters the soil and becomes available for increased microbiological activity. The decomposition of plants by micro-organisms increases the organic matter content and over long periods results in a dark surface layer. It also replaces the nutrients lost from the surface layer through leaching.

Earthworms and burrowing animals help to mix the soil material, transfer organic matter below the surface, and increase porosity.

Human activities can have an important impact on soil formation. They can alter drainage or the slope, mix soil horizons, add fertilizer or manure, and change the types of vegetation. The loamy Orthents show how these activities have mixed soil horizons and changed the slope in Sheridan County.

Relief

Relief influences the formation of soils through its effect on runoff and drainage. The slope of the soils in Sheridan County ranges from level to very steep.

Where slopes are steep, such as on shoulder slopes, most of the precipitation is lost as runoff. Therefore, vegetation is sparse and the degree leaching and profile development is restricted. Buse and Zahl are examples of soils in these areas. Bowbells, Svea, and other soils on foot slopes and in swales receive additional moisture because of their position on the landscape. Therefore, they are leached to a greater degree than other soils and have a more deeply developed profile.

Soils in depressions and on flats vary widely in profile development, depending on the degree of wetness. Tonka soils, which are in shallow depressions, exhibit an advanced degree of horizonation because of the alternating wet and dry cycles that occur in the depressions. Parnell soils, which are in the deeper depressions, exhibit a somewhat lesser degree of horizonation because they are ponded for longer periods and are exposed to fewer wet and dry cycles. Divide and Hamerly soils, which are mainly on flats, have accumulated lime in the upper part. The lime moves to the surface with the seasonal high water table and through capillary action. As the water is removed by evaporation and transpiration, an accumulation of lime is left in the surface layer and subsoil.

Time

A long time is required for the soil-forming factors to change the parent material into a soil that has distinct horizons. The soils in Sheridan County are generally about 12,000 years old or younger. This age is the approximate time since the glaciers receded. On a geologic time scale, the soils in the county are very young.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bottom land. The normal flood plain of a stream, subject to flooding.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse textured soil. Sand or loamy sand.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Depth, soil. The depth of the soil over bedrock. A very shallow soil is less than 10 inches deep over bedrock; a shallow soil, 10 to 20 inches; a moderately deep soil, 20 to 40 inches; a deep soil, 40 to 60 inches; and a very deep soil, more than 60 inches.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Lake plain. A nearly level area marking the floor of an extinct lake filled with well sorted, stratified sediments.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root shearing. The cutting, tearing, and disruption of plant roots by the hooves of animals in areas that are grazed when the soil is wet and soft.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline-sodic soil. A soil containing enough soluble salts and exchangeable sodium to interfere with the growth of plants.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey area the slope classes are:

Level	0 to 1 percent
Level and nearly level	0 to 3 percent
Nearly level	1 to 3 percent
Gently sloping or undulating	3 to 6 percent
Moderately sloping or gently rolling	6 to 9 percent
Strongly sloping or rolling	9 to 15 percent
Moderately steep or hilly	15 to 25 percent
Steep	25 to 35 percent
Very steep	more than 35 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to Ca^{++} + Mg^{++}. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Sodic soil. See Alkali (sodic) soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. An E horizon below an A horizon. If the E horizon is exposed, it is called the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop.

A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. An A horizon that is 4 to 9 inches (10 to 24 centimeters) thick.

Surface soil. An A horizon that is 10 inches (25 centimeters) or more thick.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material that is too thin for the specified use.

Till plain. An extensive area of level to undulating soils underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-87 at McClusky, North Dakota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	16.4	-3.0	6.7	44	-33	12	0.57	0.25	0.80	3	6.8
February----	23.6	3.9	13.8	48	-29	10	.48	.12	.75	2	5.6
March-------	35.3	15.0	25.2	66	-20	55	.70	.15	1.07	2	5.8
April-------	53.5	29.5	41.5	85	7	164	1.57	.32	2.55	4	3.5
May---------	68.5	41.7	55.1	92	22	475	2.18	.99	3.05	6	.4
June--------	77.2	51.4	64.3	96	37	729	3.83	1.88	5.35	7	.0
July--------	84.4	56.9	70.7	102	43	952	2.54	1.15	3.54	6	.0
August------	83.0	54.6	68.8	101	37	893	2.15	.61	3.25	5	.0
September---	70.8	44.0	57.4	98	25	522	1.62	.64	2.41	4	.1
October-----	57.6	32.9	45.3	83	13	202	.97	.19	1.57	2	1.9
November----	36.9	17.6	27.3	68	-12	36	.55	.11	.79	2	4.9
December----	23.4	4.7	14.1	50	-27	12	.53	.20	.77	2	5.3
Yearly:											
Average---	52.6	29.4	40.9	---	---	---	---	---	---	---	---
Extreme---	---	---	---	103	-34	---	---	---	---	---	---
Total-----	---	---	---	---	---	4,062	17.69	14.72	20.26	45	34.3

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-87 at McClusky, North Dakota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 16	May 21	June 3
2 years in 10 later than--	May 10	May 16	May 28
5 years in 10 later than--	Apr. 28	May 6	May 18
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 22	Sept. 10	Sept. 6
2 years in 10 earlier than--	Sept. 27	Sept. 15	Sept. 10
5 years in 10 earlier than--	Oct. 8	Sept. 25	Sept. 18

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-87 at McClusky, North Dakota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	138	121	102
8 years in 10	146	128	109
5 years in 10	162	141	122
2 years in 10	178	154	135
1 year in 10	186	161	142

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Marysland loam	2,830	0.5
6	Harriet silt loam	6,410	1.0
7	Fossum loamy sand	2,100	0.3
10	Southam silty clay loam	29,880	4.7
11	Parnell silt loam	12,840	2.0
12	Parnell-Vallers complex, 0 to 3 percent slopes	7,960	1.3
15	Divide loam, 0 to 3 percent slopes	4,320	0.7
18	Fram and Vallers loams, saline, 0 to 3 percent slopes	6,450	1.0
19	Tonka silt loam	1,240	0.2
23	Marysland silt loam, channeled	2,630	0.4
24C	Barnes-Buse loams, 6 to 9 percent slopes	59,470	9.3
26B	Barnes-Cresbard loams, 1 to 6 percent slopes	11,750	1.8
30	Svea-Barnes loams, 0 to 3 percent slopes	5,610	0.9
30B	Barnes-Svea loams, 3 to 6 percent slopes	55,400	8.6
32C	Barnes-Buse-Parnell complex, 0 to 9 percent slopes	7,430	1.2
32F	Barnes-Buse-Parnell complex, 0 to 35 percent slopes	10,970	1.7
35B	Overly silty clay loam, 0 to 6 percent slopes	3,140	0.5
36D	Buse-Barnes loams, 9 to 15 percent slopes	26,780	4.2
36F	Buse-Barnes loams, 15 to 35 percent slopes	6,030	0.9
37B	Cresbard-Cavour loams, 0 to 6 percent slopes	8,820	1.4
38	Miranda loam, 0 to 3 percent slopes	5,200	0.8
40F	Orthents, loamy, 1 to 75 percent slopes	3,630	0.6
41C	Towner-Maddock-Buse complex, 1 to 9 percent slopes	4,670	0.7
41E	Towner-Maddock-Buse complex, 9 to 25 percent slopes	900	0.1
42B	Towner loamy fine sand, 0 to 6 percent slopes	2,300	0.4
44B	Swenoda sandy loam, 0 to 6 percent slopes	7,710	1.2
45B	Cathay-Emrick loams, 0 to 6 percent slopes	6,170	1.0
46	Larson-Cathay loams, 0 to 3 percent slopes	2,800	0.4
53B	Renshaw loam, 0 to 6 percent slopes	4,520	0.7
54B	Arvilla sandy loam, 0 to 6 percent slopes	13,660	2.1
57	Hamerly-Tonka complex, 0 to 3 percent slopes	11,400	1.8
62	Heimdal-Emrick loams, 0 to 3 percent slopes	34,930	5.4
62B	Heimdal-Emrick loams, 3 to 6 percent slopes	35,940	5.6
63D	Esmond-Heimdal loams, 9 to 15 percent slopes	5,300	0.8
63F	Esmond-Heimdal loams, 15 to 35 percent slopes	3,940	0.6
64C	Heimdal-Esmond loams, 6 to 9 percent slopes	15,040	2.3
65B	Maddock loamy fine sand, 0 to 6 percent slopes	5,410	0.8
67B	Lehr loam, 0 to 6 percent slopes	3,500	0.5
73D	Zahl-Williams loams, 9 to 15 percent slopes	28,530	4.4
73F	Zahl-Williams loams, 15 to 35 percent slopes	16,200	2.5
74	Fram loam, 0 to 3 percent slopes	2,000	0.3
75	Fram-Tonka complex, 0 to 3 percent slopes	8,120	1.3
76C	Sioux-Arvilla complex, 1 to 9 percent slopes	10,170	1.6
77B	Nutley silty clay, 0 to 6 percent slopes	7,230	1.1
79F	Arvilla and Sioux soils, 9 to 35 percent slopes	7,340	1.1
81C	Wabek sandy loam, 1 to 9 percent slopes	11,630	1.8
81F	Wabek sandy loam, 9 to 35 percent slopes	8,640	1.3
83B	Williams-Bowbells loams, 3 to 6 percent slopes	20,000	3.1
86C	Williams-Zahl loams, 6 to 9 percent slopes	38,820	6.0
95	Pits, sand and gravel	300	*
99C	Williams-Zahl-Parnell complex, 0 to 9 percent slopes	12,570	2.0
99F	Zahl-Williams-Parnell complex, 0 to 35 percent slopes	22,750	3.5
	Water	10,320	1.6
	Total	643,700	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. For poorly drained and very poorly drained soils, however, the yields are those expected in undrained areas. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
2------------------------ Marysland	16	34	26	8	800	2.8
6------------------------ Harriet	---	---	---	---	---	1.6
7------------------------ Fossum	12	26	20	6	600	2.8
10. Southam						
11----------------------- Parnell	9	19	15	5	450	---
12*---------------------- Parnell-Vallers	12	26	20	6	600	1.0
15----------------------- Divide	25	53	41	---	1,250	2.3
18*---------------------- Fram and Vallers	12	26	20	6	600	2.1
19----------------------- Tonka	16	34	26	8	800	2.8
23----------------------- Marysland	---	---	---	---	---	2.8
24C*--------------------- Barnes-Buse	21	45	34	11	1,050	2.1
26B*--------------------- Barnes-Cresbard	30	64	45	15	1,500	2.1
30*---------------------- Svea-Barnes	35	74	57	18	1,750	2.7
30B*--------------------- Barnes-Svea	30	64	49	15	1,500	2.6
32C*--------------------- Barnes-Buse-Parnell	18	38	29	9	900	1.4
32F*. Barnes-Buse-Parnell						
35B---------------------- Overly	34	72	55	17	1,700	2.6
36D*--------------------- Buse-Barnes	---	---	---	---	---	1.8
36F*. Buse-Barnes						

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
37B*: Cresbard-Cavour	24	51	39	12	1,200	1.5
38: Miranda	---	---	---	---	---	0.9
40F. Orthents, loamy						
41C*: Towner-Maddock-Buse	18	38	29	9	900	1.7
41E*. Towner-Maddock-Buse						
42B: Towner	20	43	33	10	1,000	1.8
44B: Swenoda	29	62	47	15	1,450	2.1
45B*: Cathay-Emrick	30	64	49	15	1,500	2.1
46*: Larson-Cathay	19	40	31	10	950	1.5
53B: Renshaw	15	32	24	8	750	1.8
54B: Arvilla	15	32	24	8	750	1.8
57*: Hamerly-Tonka	28	60	46	14	1,400	2.5
62*: Heimdal-Emrick	34	72	55	17	1,700	2.7
62B*: Heimdal-Emrick	29	62	47	15	1,450	2.6
63D*: Esmond-Heimdal	---	---	---	---	---	1.8
63F* Esmond-Heimdal						
64C*: Heimdal-Esmond	20	43	33	10	1,000	2.1
65B: Maddock	17	36	28	---	850	1.8
67B: Lehr	16	34	26	8	800	1.6
73D*: Zahl-Williams	---	---	---	---	---	1.6

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
73F*. Zahl-Williams						
74 Fram	31	66	50	16	1,550	2.3
75* Fram-Tonka	28	60	46	14	1,400	2.5
76C* Sioux-Arvilla	---	---	---	---	---	1.4
77B Nutley	32	68	52	16	1,600	2.2
79F*. Arvilla and Sioux						
81C Wabek	---	---	---	---	---	0.9
81F. Wabek						
83B* Williams-Bowbells	32	68	52	16	1,600	2.3
86C* Williams-Zahl	20	43	33	10	---	1.8
95*. Pits, sand and gravel						
99C* Williams-Zahl-Parnell	18	38	29	9	900	1.4
99F*. Zahl-Williams-Parnell						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
2: Marysland	Subirrigated	4,800	4,400	3,900
6: Harriet	Saline Lowland	3,200	2,800	2,400
7: Fossum	Subirrigated	5,000	4,500	4,000
11: Parnell	Wetland	7,000	6,600	6,000
12*:				
Parnell	Wetland	7,000	6,600	6,000
Vallers	Subirrigated	4,800	4,400	3,900
15: Divide	Limy Subirrigated	4,800	4,200	3,600
18*:				
Fram	Saline Lowland	3,500	3,200	2,800
Vallers	Saline Lowland	4,000	3,500	3,000
19: Tonka	Wet Meadow	5,000	4,500	4,000
23: Marysland	Subirrigated	4,800	4,400	3,900
24C*:				
Barnes	Silty	3,200	2,700	2,300
Buse	Thin Upland	2,800	2,500	2,100
26B*:				
Barnes	Silty	3,200	2,700	2,300
Cresbard	Clayey	2,800	2,400	2,000
30*:				
Svea	Overflow	4,000	3,600	3,100
Barnes	Silty	3,200	2,700	2,300
30B*:				
Barnes	Silty	3,200	2,700	2,300
Svea	Silty	3,500	3,000	2,600
32C*, 32F*:				
Barnes	Silty	3,200	2,700	2,300
Buse	Thin Upland	2,800	2,500	2,100

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
32C*, 32F*:				
Parnell	Wetland	7,000	6,600	6,000
35B Overly	Silty	3,400	2,900	2,500
36D*, 36F*:				
Buse	Thin Upland	2,800	2,500	2,100
Barnes	Silty	3,200	2,700	2,300
37B*:				
Cresbard	Clayey	2,800	2,400	2,000
Cavour	Claypan	2,300	2,000	1,600
38 Miranda	Thin Claypan	1,300	1,100	900
40F Orthents, loamy	Thin Upland	2,800	2,500	2,100
41C*, 41E*:				
Towner	Sands	3,300	2,900	2,500
Maddock	Sands	3,300	2,900	2,500
Buse	Thin Upland	2,800	2,500	2,100
42B Towner	Sands	3,300	2,900	2,500
44B Swenoda	Sandy	3,200	2,800	2,400
45B*:				
Cathay	Clayey	2,800	2,400	2,000
Emrick	Silty	3,400	2,900	2,500
46*:				
Larson	Claypan	2,300	2,000	1,600
Cathay	Clayey	2,800	2,400	2,000
53B Renshaw	Shallow to Gravel	2,100	1,900	1,600
54B Arvilla	Shallow to Gravel	2,100	1,900	1,600
57*:				
Hamerly	Limy Subirrigated	4,800	4,200	3,600
Tonka	Wet Meadow	5,000	4,500	4,000
62*:				
Heimdal	Silty	3,200	2,700	2,300

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season: Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
62*:				
Emrick	Overflow	3,900	3,500	3,000
62B*:				
Heimdal	Silty	3,200	2,700	2,300
Emrick	Silty	3,400	2,900	2,500
63D*, 63F*:				
Esmond	Thin Upland	2,800	2,500	2,100
Heimdal	Silty	3,200	2,700	2,300
64C*:				
Heimdal	Silty	3,200	2,700	2,300
Esmond	Thin Upland	2,800	2,500	2,100
65B Maddock	Sands	3,300	2,900	2,500
67B Lehr	Shallow to Gravel	1,900	1,600	1,300
73D*, 73F*:				
Zahl	Thin Upland	2,300	1,900	1,600
Williams	Silty	2,500	2,100	1,700
74 Fram	Limy Subirrigated	4,800	4,200	3,600
75*:				
Fram	Limy Subirrigated	4,800	4,200	3,600
Tonka	Wet Meadow	5,000	4,500	4,000
76C*:				
Sioux	Very Shallow	1,200	1,000	800
Arvilla	Shallow to Gravel	2,100	1,900	1,600
77B Nutley	Clayey	3,000	2,600	2,200
79F*:				
Arvilla	Shallow to Gravel	2,100	1,900	1,600
Sioux	Very Shallow	1,200	1,000	800
81C, 81F Wabek	Very Shallow	1,000	800	600
83B*:				
Williams	Silty	2,500	2,100	1,700
Bowbells	Silty	2,700	2,300	1,900

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season: Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
86C*:				
Williams	Silty	2,500	2,100	1,700
Zahl	Thin Upland	2,300	1,900	1,600
99C*:				
Williams	Silty	2,500	2,100	1,700
Zahl	Thin Upland	2,300	1,900	1,600
Parnell	Wetland	6,000	5,500	5,000
99F*:				
Zahl	Thin Upland	2,300	1,900	1,600
Williams	Silty	2,500	2,100	1,700
Parnell	Wetland	6,000	5,500	5,000

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on the soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
2: Marysland	---	Redosier dogwood, eastern redcedar, American plum, lilac, common chokecherry, Siberian peashrub.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow	Eastern cottonwood.
6. Harriet					
7: Fossum	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
10. Southam					
11: Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
12*:					
Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Vallers	---	Redosier dogwood, eastern redcedar, American plum, lilac, common chokecherry, Siberian peashrub.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow	Eastern cottonwood.
15: Divide	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
18*:					
Fram	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
19 Tonka	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
23 Marysland	---	Redosier dogwood, eastern redcedar, American plum, lilac, common chokecherry, Siberian peashrub.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow	Eastern cottonwood.
24C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
26B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Cresbard	Peking cotoneaster	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
30*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
30B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
32C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
32F*:					
Barnes.					
Buse.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
32F*:					
Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
35B Overly	---	Siberian peashrub, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
36D*:					
Buse.					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
36F*:					
Buse.					
Barnes.					
37B*:					
Cresbard	Peking cotoneaster	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
38. Miranda					
40F. Orthents, loamy					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
41C*:					
Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Siberian crabapple, American plum, silver buffaloberry.	Ponderosa pine, green ash, Russian-olive, bur oak.	---	---
Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, lilac, American plum, Siberian crabapple.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
Buse	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
41E*					
Towner.					
Maddock.					
Buse.					
42B Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Siberian crabapple, American plum, silver buffaloberry.	Ponderosa pine, green ash, Russian-olive, bur oak.	---	---
44B Swenoda	---	Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, silver buffaloberry, American plum, lilac.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
45B*:					
Cathay	---	Common chokecherry, eastern redcedar, Peking cotoneaster, Russian-olive, silver buffaloberry, Siberian peashrub, lilac.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
Emrick	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
46*:					
Larson	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
Cathay	---	Common chokecherry, eastern redcedar, Peking cotoneaster, Russian-olive, silver buffaloberry, Siberian peashrub, lilac.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
53B Renshaw	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, eastern redcedar, Rocky Mountain juniper, Siberian crabapple, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
54B Arvilla	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
57*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
62*, 62B*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Emrick	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
63D*:					
Esmond.					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
63F*:					
Esmond.					
Heimdal.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
64C*:					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Esmond	Siberian peashrub	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
65B: Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, lilac, American plum, Siberian crabapple.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
67B: Lehr	---	Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
73D*: Zahl.					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
73F*: Zahl.	---	---	---	---	---
Williams.	---	---	---	---	---
74: Fram	---	Redosier dogwood, ponderosa pine, Siberian peashrub, American plum, eastern redcedar, Peking cotoneaster, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
75*:					
Fram	---	Redosier dogwood, ponderosa pine, Siberian peashrub, American plum, eastern redcedar, Peking cotoneaster, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
76C*:					
Sioux.					
Arvilla	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---
77B Nutley	---	Eastern redcedar, Siberian peashrub, Russian-olive, lilac, Peking cotoneaster, common chokecherry, silver buffaloberry.	Siberian elm, Siberian crabapple, green ash, ponderosa pine.	---	---
79F*:					
Arvilla.					
Sioux.					
81C, 81F. Wabek					
83B*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
83B*:					
Bowbells	---	Siberian crabapple, peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Golden willow, green ash, Black Hills spruce.	---	Plains cottonwood.
86C*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Zahl	Eastern redcedar, Siberian peashrub.	Ponderosa pine, green ash, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
95*. Pits, sand and gravel					
99C*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Zahl	Eastern redcedar, Siberian peashrub.	Ponderosa pine, green ash, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
Parnell	Siberian peashrub, American plum, redosier dogwood.	Black Hills spruce, common chokecherry, Siberian crabapple, lilac, eastern redcedar.	Green ash	Golden willow	Plains cottonwood.
99F*:					
Zahl.					
Williams.					
Parnell	Siberian peashrub, American plum, redosier dogwood.	Black Hills spruce, common chokecherry, Siberian crabapple, lilac, eastern redcedar.	Green ash	Golden willow	Plains cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the map unit was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2: Marysland	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
6: Harriet	Severe: flooding, wetness, percs slowly.	Severe: wetness, excess sodium, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.
7: Fossum	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
10: Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
11: Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
12*:				
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Vallers	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
15: Divide	Slight	Slight	Slight	Slight.
18*:				
Fram	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
Vallers	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
19: Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
23: Marysland	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
24C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
26B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
30*:				
Svea	Slight	Slight	Moderate: small stones.	Slight.
Barnes	Slight	Slight	Moderate: small stones.	Slight.
30B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
32C*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
32F*:				
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
35B Overly	Slight	Slight	Moderate: slope.	Slight.
36D*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
36F*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
37B*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
38 Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
40F. Orthents, loamy				
41C*:				
Towner	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Maddock	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Buse	Slight	Slight	Severe: slope.	Slight.
41E*:				
Towner	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Maddock	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
42B Towner	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
44B Swenoda	Slight	Slight	Moderate: slope.	Slight.
45B*:				
Cathay	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Emrick	Slight	Slight	Moderate: slope.	Slight.
46*:				
Larson	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cathay	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
53B Renshaw	Slight	Slight	Moderate: slope.	Slight.
54B Arvilla	Slight	Slight	Moderate: slope.	Slight.
57*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
57*:				
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
62*:				
Heimdal	Slight	Slight	Slight	Slight.
Emrick	Slight	Slight	Slight	Slight.
62B*:				
Heimdal	Slight	Slight	Moderate: slope.	Slight.
Emrick	Slight	Slight	Moderate: slope.	Slight.
63D*:				
Esmond	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Heimdal	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
63F*:				
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
64C*:				
Heimdal	Slight	Slight	Severe: slope.	Slight.
Esmond	Slight	Slight	Severe: slope.	Slight.
65B Maddock	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
67B Lehr	Slight	Slight	Moderate: slope.	Slight.
73D*:				
Zahl	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Williams	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
73F*:				
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Williams	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
74 Fram	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
75*:				
Fram	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
76C*:				
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
Arvilla	Slight	Slight	Moderate: slope.	Slight.
77B Nutley	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
79F*:				
Arvilla	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
81C Wabek	Slight	Slight	Moderate: slope.	Slight.
81F Wabek	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
83B*:				
Williams	Slight	Slight	Moderate: slope.	Slight.
Bowbells	Slight	Slight	Moderate: slope.	Slight.
86C*:				
Williams	Slight	Slight	Severe: slope.	Slight.
Zahl	Slight	Slight	Severe: slope.	Slight.
95*. Pits, sand and gravel				
99C*:				
Williams	Slight	Slight	Moderate: slope.	Slight.
Zahl	Slight	Slight	Severe: slope.	Slight.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
99F*:				
Zahl-----------------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Williams-------------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Parnell--------------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the map unit was not rated)

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
2 Marysland	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
6 Harriet	Poor	Poor	Fair	Very poor	Good	Good	Poor	Good	Poor.
7 Fossum	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
10 Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
11 Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
12*:									
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
Vallers	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
15 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
18*:									
Fram	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Fair	Fair.
Vallers	Poor	Fair	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
19 Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
23 Marysland	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
24C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
26B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
30*:									
Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
30B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
32C*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
32F*:									
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Buse	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
35B Overly	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
36D*:									
Buse	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
36F*:									
Buse	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
37B*:									
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
38 Miranda	Poor	Poor	Very poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
40F. Orthents, loamy									
41C*:									
Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
41E*:									
Towner	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Maddock	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Buse	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
42B Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
44B Swenoda	Fair	Fair	Good	---	Very poor	Very poor	Fair	Very poor	Good.
45B*:									
Cathay	Fair	Good	Good	Poor	Poor	Very poor	Fair	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
45B*:									
Emrick	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
46*:									
Larson	Poor	Poor	Poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Cathay	Fair	Good	Good	Poor	Poor	Poor	Fair	Poor	Fair.
53B Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
54B Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
57*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
62*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
62B*:									
Heimdal	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
63D*:									
Esmond	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Heimdal	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
63F*:									
Esmond	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Heimdal	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
64C*:									
Heimdal	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Esmond	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
65B Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
67B Lehr	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
73D*:									
Zahl	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Williams	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
73F*:									
Zahl	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Williams	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
74 Fram	Good	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
75*:									
Fram	Good	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
76C*:									
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
77B Nutley	Good	Good	Fair	Poor	Very poor	Very poor	Good	Very poor	Poor.
79F*:									
Arvilla	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
81C, 81F Wabek	Very poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
83B*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Bowbells	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
86C*:									
Williams	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zahl	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
95*. Pits, sand and gravel									
99C*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zahl	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
99F*:									
Zahl	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Williams	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2----------------- Marysland	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
6----------------- Harriet	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
7----------------- Fossum	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
10---------------- Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
11---------------- Parnell	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
12*: Parnell----------	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
Vallers----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
15---------------- Divide	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
18*: Fram-------------	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Vallers----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
19---------------- Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
23---------------- Marysland	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
24C*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Buse-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
26B*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
Cresbard---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
30*:					
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
30B*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
32C*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Buse-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Parnell----------	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
32F*:					
Barnes-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Buse-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Parnell----------	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
35B------- Overly	Moderate: too clayey, wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
36D*:					
Buse-------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Barnes-------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
36F*:					
Buse-------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes-------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
37B*:					
Cresbard-------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Cavour-------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
38------- Miranda	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, low strength, wetness.
40F. Orthents, loamy					
41C*:					
Towner-------	Severe: cutbanks cave.	Slight-------	Moderate: shrink-swell.	Slight-------	Moderate: frost action.
Maddock-------	Severe: cutbanks cave.	Slight-------	Slight-------	Slight-------	Slight.
Buse-------	Slight-------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
41E*:					
Towner-------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, frost action.
Maddock-------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Buse-------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
42B: Towner	Severe: cutbanks cave.	Slight	Moderate: shrink-swell.	Slight	Moderate: frost action.
44B: Swenoda	Slight	Slight	Moderate: shrink-swell.	Slight	Moderate: frost action.
45B*:					
Cathay	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Emrick	Slight	Slight	Slight	Slight	Moderate: frost action.
46*:					
Larson	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Cathay	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
53B: Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
54B: Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
57*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
62*:					
Heimdal	Slight	Slight	Slight	Slight	Moderate: frost action.
Emrick	Slight	Slight	Slight	Slight	Moderate: frost action.
62B*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Emrick	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
63D*:					
Esmond	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Heimdal	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
63F*:					
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
64C*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Esmond	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
65B Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
67B Lehr	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
73D*:					
Zahl	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Williams	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
73F*:					
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Williams	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
74 Fram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
75*:					
Fram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
76C*:					
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Arvilla	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
77B Nutley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
79F*:					
Arvilla----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sioux------------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
81C--------------- Wabek	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Slight.
81F--------------- Wabek	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
83B*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
86C*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Zahl-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
95*. Pits, sand and gravel					
99C*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Zahl-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Parnell----------	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
99F*:					
Zahl-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Williams---------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
99F*:					
Parnell----------	Severe: excess humus, ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2------------------ Marysland	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
6------------------ Harriet	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
7------------------ Fossum	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
10----------------- Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
11----------------- Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
12*:					
Parnell------------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Vallers------------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
15----------------- Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
18*:					
Fram---------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Vallers------------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
19----------------- Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
23------------------ Marysland	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
24C*:					
Barnes-------------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Buse---------------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
26B*:					
Barnes-------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Cresbard-----------	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
30*:					
Svea---------------	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes-------------	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
30B*:					
Barnes-------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Svea---------------	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
32C*:					
Barnes-------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Buse---------------	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Parnell------------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack ponding.
32F*:					
Barnes-------------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Buse---------------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
32F*:					
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
35B Overly	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness.	Moderate: wetness.	Poor: thin layer.
36D*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
36F*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
37B*:					
Cresbard	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Cavour	Severe: percs slowly.	Moderate: slope.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
38 Miranda	Severe: wetness, percs slowly.	Slight	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
40F. Orthents, loamy					
41C*:					
Towner	Severe: percs slowly, poor filter.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
41E*:					
Towner	Severe: percs slowly, poor filter.	Severe: seepage, slope.	Moderate: slope, too clayey.	Severe: seepage.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
41E*:					
Maddock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
42B Towner	Severe: percs slowly, poor filter.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
44B Swenoda	Severe: percs slowly.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
45B*:					
Cathay	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Emrick	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
46*:					
Larson	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Cathay	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
53B Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
54B Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
57*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
62*:					
Heimdal	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
Emrick	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
62B*:					
Heimdal	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Emrick	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
63D*:					
Esmond	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Heimdal	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
63F*:					
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Heimdal	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
64C*:					
Heimdal	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
Esmond	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
65B Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
67B Lehr	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
73D*:					
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Williams	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
73F*:					
Zahl	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Williams	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
74 Fram	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
75*:					
Fram	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
76C*:					
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
77B Nutley	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
79F*:					
Arvilla	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
81C Wabek	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
81F Wabek	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
83B*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
86C*:					
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
95*. Pits, sand and gravel					
99C*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Zahl	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
99F*:					
Zahl	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Williams	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2: Marysland	Poor: wetness.	Probable	Probable	Poor: wetness.
6: Harriet	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, wetness.
7: Fossum	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
10: Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
11: Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
12*:				
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Vallers	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15: Divide	Fair: wetness.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
18*:				
Fram	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
19: Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
23: Marysland	Poor: wetness.	Probable	Probable	Poor: wetness.
24C*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
24C*:				
Buse	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
26B*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
30*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
30B*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
32C*:				
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Buse	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
32F*:				
Barnes	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Buse	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
35B------------------- Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
36D*:				
Buse-----------------	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Barnes---------------	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
36F*:				
Buse-----------------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes---------------	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
37B*:				
Cresbard-------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
Cavour---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
38-------------------- Miranda	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
40F. Orthents, loamy				
41C*:				
Towner---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Maddock--------------	Good-----------------	Probable-------------	Improbable: too sandy.	Poor: too sandy.
Buse-----------------	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
41E*:				
Towner---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Maddock--------------	Fair: slope.	Probable-------------	Improbable: too sandy.	Poor: too sandy, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
41E*:				
Buse	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
42B Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
44B Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
45B*:				
Cathay	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
46*:				
Larson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, excess sodium.
Cathay	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
53B Renshaw	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
54B Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
57*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
62*, 62B*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
63D*:				
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
63D*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
63F*:				
Esmond	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Heimdal	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
64C*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
65B Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
67B Lehr	Good	Probable	Probable	Poor: small stones, area reclaim.
73D*:				
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
73F*:				
Zahl	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Williams	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
74 Fram	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
75*:				
Fram	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
76C*:				
Sioux	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
76C*:				
Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
77B Nutley	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
79F*:				
Arvilla	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Sioux	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
81C Wabek	Good	Probable	Probable	Poor: small stones, area reclaim.
81F Wabek	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
83B*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
86C*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
95*. Pits, sand and gravel				
99C*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
99F*:				
Zahl------------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Williams--------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Parnell---------------	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the map unit was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
2 Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
6 Harriet	Severe: seepage.	Severe: piping, wetness, excess sodium.	Percs slowly, flooding, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, excess sodium, erodes easily.
7 Fossum	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
10 Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
11 Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
12*:						
Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
Vallers	Slight	Severe: piping, wetness.	Frost action	Wetness	Wetness	Wetness.
15 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
18*:						
Fram	Moderate: seepage.	Severe: piping.	Frost action, excess salt.	Wetness	Wetness, erodes easily.	Excess salt, erodes easily.
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
19 Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
23 Marysland	Severe: seepage.	Severe: seepage, wetness.	Flooding, frost action, cutbanks cave.	Wetness, flooding.	Wetness, too sandy.	Wetness.
24C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
24C*:						
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
26B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
30*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
30B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
32C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
32F*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
35B Overly	Moderate: slope.	Severe: piping.	Deep to water	Slope, percs slowly.	Favorable	Percs slowly.
36D*, 36F*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
37B*:						
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
Cavour	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
38 Miranda	Slight	Severe: piping, excess sodium.	Percs slowly, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess sodium, percs slowly.
40F. Orthents, loamy						
41C*:						
Towner	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Erodes easily, soil blowing.	Erodes easily, droughty.
Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
41E*:						
Towner	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Slope, erodes easily, soil blowing.	Slope, erodes easily, droughty.
Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
42B Towner	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Erodes easily, soil blowing.	Erodes easily, droughty.
44B Swenoda	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily.
45B*:						
Cathay	Moderate: seepage, slope.	Severe: piping, excess sodium.	Deep to water	Slope, percs slowly.	Favorable	Excess sodium, percs slowly.
Emrick	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
46*:						
Larson	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly	Favorable	Excess sodium, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
46*:						
Cathay	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly	Favorable	Excess sodium, percs slowly.
53B Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty.	Too sandy	Droughty.
54B Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
57*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
62*:						
Heimdal	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Emrick	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
62B*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Emrick	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
63D*, 63F*:						
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Heimdal	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
64C*:						
Heimdal	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Esmond	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
65B Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
67B Lehr	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty.	Too sandy	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
73D*, 73F*:						
Zahl	Severe: slope.	Severe: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Williams	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.
74 Fram	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
75*:						
Fram	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
76C*:						
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty.	Too sandy	Droughty.
Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
77B Nutley	Moderate: slope.	Moderate: hard to pack.	Deep to water	Slope, droughty, slow intake.	Percs slowly	Droughty, percs slowly.
79F*:						
Arvilla	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty.	Slope, too sandy.	Slope, droughty.
81C Wabek	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty.	Too sandy, soil blowing.	Droughty.
81F Wabek	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.
83B*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
86C*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
86C*:						
Zahl	Moderate: slope.	Severe: piping.	Deep to water	Slope, percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
95*. Pits, sand and gravel						
99C*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Zahl	Moderate: slope.	Severe: piping.	Deep to water	Slope, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
99F*:						
Zahl	Severe: slope.	Severe: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Williams	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.
Parnell	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
2	0-9	Loam	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	9-24	Locam, clay loam	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	24-60	Fine sand, gravelly sand, very gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
6 Harriet	0-1	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
	1-9	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-100	35-70	20-40
	9-42	Very fine sandy loam to silty clay.	CL, CL-ML, CH	A-4, A-6, A-7	0	100	100	90-100	60-100	20-65	5-40
	42-60	Loamy sand, fine sand, gravelly loamy sand.	---	---	0	75-100	70-100	20-80	5-45	<20	NP-5
7 Fossum	0-17	Loamy sand	SM, SP-SM	A-2	0	100	100	60-80	10-35	<20	NP-4
	17-24	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-30	---	NP
	24-60	Loamy sand, loamy fine sand, fine sand.	SP-SM, SM	A-3, A-2	0	95-100	95-100	60-100	5-20	---	NP
10 Southam	0-6	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	80-100	30-50	10-25
	6-60	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
11 Parnell	0-7	Silt loam	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	7-37	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	37-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
12*:											
Parnell	0-7	Silt loam	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	7-37	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	37-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
Vallers	0-7	Loam	ML, CL-ML	A-4	0-5	95-100	90-100	80-90	50-80	30-40	4-10
	7-20	Clay loam, silty clay loam, loam.	CL	A-6	0-5	95-100	90-100	80-95	50-80	30-40	11-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-85	20-40	5-20
15 Divide	0-8	Loam	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	8-30	Loam, sandy loam, gravelly loam.	CL, CL-ML, SC-SM, SC	A-4, A-6, A-7	0-3	95-100	75-100	55-90	35-80	20-45	5-20
	30-60	Loamy sand to gravelly sand.	GM, SM, GP-GM, SP-SM	A-1, A-3	0-5	25-100	15-100	10-70	5-25	<30	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
18*:											
Fram	0-31	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	31-60	Sandy loam, fine sandy loam, loam.	SM, ML	A-4	0-1	95-100	95-100	60-100	35-90	20-40	NP-10
Vallers	0-7	Loam	ML	A-4	0-5	95-100	90-100	80-90	65-80	25-40	3-10
	7-20	Clay loam, silty clay loam, loam.	CL	A-6	0-5	95-100	90-100	80-95	50-80	30-40	10-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-20
19 Tonka	0-21	Silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	21-49	Silty clay loam, silty clay, clay loam.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	49-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
23 Marysland	0-9	Silt loam	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	9-24	Loam, clay loam	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	24-60	Fine sand, gravelly sand, very gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
24C*:											
Barnes	0-5	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse	0-6	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
26B*:											
Barnes	0-5	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-23	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Cresbard	0-6	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	6-27	Clay loam, silty clay loam, clay.	CL, CH	A-7, A-6	0	95-100	90-100	90-100	65-85	30-60	15-30
	27-44	Clay loam, silty clay, clay.	CL, CH	A-7	0	95-100	90-100	85-100	65-85	40-60	15-30
	44-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	50-80	25-55	10-27
30*:											
Svea	0-8	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-26	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
Barnes	0-5	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
30B*:											
Barnes----------	0-5	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea-----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-26	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
32C*, 32F*:											
Barnes----------	0-5	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse-----------	0-6	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Parnell---------	0-7	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	7-37	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	37-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
35B------------- Overly	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
	10-42	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	42-60	Silt loam, silty clay loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
36D*, 36F*:											
Buse-----------	0-6	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Barnes----------	0-5	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
37B*:											
Cresbard--------	0-6	Loam-------------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	6-27	Clay loam, silty clay loam, clay.	CL, CH	A-7, A-6	0	95-100	90-100	90-100	65-85	30-60	15-30
	27-44	Clay loam, silty clay, clay.	CL, CH	A-7	0	95-100	90-100	85-100	65-85	40-60	15-30
	44-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	50-80	25-55	10-27
Cavour----------	0-8	Loam-------------	ML, MH	A-4, A-6, A-7	0	100	90-100	85-100	60-85	30-55	5-20
	8-46	Silty clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7, A-6	0	100	90-100	90-100	55-85	35-65	15-30
	46-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	90-100	75-100	50-85	35-65	12-35

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
38--------------- Miranda	0-1	Loam-------------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	20-40	3-15
	1-21	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-30
	21-60	Loam, clay loam, sandy loam.	CL, ML, SM	A-6, A-7, A-4	0-5	95-100	95-100	60-95	30-80	20-50	NP-30
40F. Orthents, loamy											
41C*, 41E*: Towner----------	0-8	Loamy fine sand	SM, SC-SM	A-2	0	100	100	50-80	15-35	<25	NP-5
	8-30	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SW-SM, SP-SM	A-2, A-3	0	100	95-100	50-100	5-35	<25	NP-5
	30-60	Clay loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-100	55-100	25-50	5-30
Maddock---------	0-11	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	11-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Buse------------	0-6	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
42B-------------- Towner	0-8	Loamy fine sand	SM, SC-SM	A-2	0	100	100	50-80	15-35	<25	NP-5
	8-30	Loamy sand, loamy fine sand, fine sand.	SM, SC-SM, SW-SM, SP-SM	A-2, A-3	0	100	95-100	50-100	5-35	<25	NP-5
	30-60	Clay loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-100	55-100	25-50	5-30
44B-------------- Swenoda	0-7	Sandy loam-------	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	7-31	Fine sandy loam, sandy loam.	SC-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-60	15-30	NP-10
	31-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	20-50	5-30
45B*: Cathay----------	0-7	Loam-------------	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	7-22	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	60-85	25-40	10-25
	22-60	Loam-------------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-25
Emrick----------	0-8	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	<40	NP-10
	8-22	Loam-------------	ML, CL	A-4	0-1	95-100	95-100	85-95	55-75	<40	NP-10
	22-60	Loam, sandy loam	ML, SM, SC	A-4, A-6	0-5	90-100	90-100	60-100	35-90	<40	NP-10
46*: Larson----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-100	50-90	15-40	5-20
	8-23	Fine sandy loam, clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	85-100	75-100	60-80	30-45	10-30
	23-60	Loam, clay loam, silt loam.	CL, CL-ML	A-6, A-4, A-7	0-5	95-100	85-100	75-100	50-90	15-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
46*:											
Cathay----------	0-7	Loam------------	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	7-22	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	60-85	25-40	10-25
	22-60	Loam------------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-25
53B-------------- Renshaw	0-6	Loam------------	ML	A-4	0-5	95-100	90-100	70-100	50-75	20-40	NP-10
	6-15	Loam, sandy clay loam, gravelly loam.	SC-SM, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	20-40	3-15
	15-60	Gravelly loamy sand, very gravelly loamy sand, very gravelly coarse sand.	SW, SM, SW-SM, GW-GM	A-1, A-2	0-5	45-95	30-80	10-60	0-15	<25	NP-5
54B-------------- Arvilla	0-7	Sandy loam-------	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
	7-17	Sandy loam, loam, coarse sandy loam.	SM, SC, SC-SM	A-2, A-4, A-6	0	90-100	85-100	50-80	20-45	<40	NP-15
	17-60	Gravelly coarse sand, sand, gravelly loamy sand.	SP-SM, GP, SM, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-15	---	NP
57*:											
Hamerly---------	0-7	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-28	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Tonka-----------	0-21	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	21-49	Silty clay loam, silty clay, clay loam.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	49-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
62*, 62B*:											
Heimdal---------	0-7	Loam------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-18	Loam------------	ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	18-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Emrick----------	0-8	Loam------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	<40	NP-10
	8-22	Loam------------	ML, CL	A-4	0-1	95-100	95-100	85-95	55-75	<40	NP-10
	22-60	Loam, sandy loam	ML, SM, SC	A-4, A-6	0-5	90-100	90-100	60-100	35-90	<40	NP-10
63D*, 63F*:											
Esmond----------	0-4	Loam------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	4-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
63D*, 63F*:											
Heimdal----------	0-7	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-18	Loam-------------	ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	18-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
64C*:											
Heimdal----------	0-7	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-18	Loam-------------	ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	18-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Esmond-----------	0-4	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	4-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
65B-------------- Maddock	0-11	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	11-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
67B-------------- Lehr	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-80	20-40	3-15
	7-15	Loam, clay loam	CL, CL-ML, SC, SC-SM	A-4, A-6	0-5	95-100	90-100	80-95	45-75	25-40	5-15
	15-60	Gravelly loamy sand, gravelly sand, very gravelly coarse sand.	SM, SP, GM, GP	A-1	0-5	40-80	25-60	10-35	2-15	---	NP
73D*, 73F*:											
Zahl-------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-16	Loam, clay loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30
	16-60	Clay loam, loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30
Williams---------	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
74--------------- Fram	0-31	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	31-60	Sandy loam, fine sandy loam, loam.	SM, ML	A-4	0-1	95-100	95-100	60-100	35-90	20-40	NP-10
75*:											
Fram-------------	0-31	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	31-60	Sandy loam, fine sandy loam, loam.	SM, ML	A-4	0-1	95-100	95-100	60-100	35-90	20-40	NP-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
75*:											
Tonka-----------	0-21	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	21-49	Silty clay loam, silty clay, clay loam.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	49-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
76C*:											
Sioux-----------	0-6	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	6-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
Arvilla---------	0-7	Sandy loam-------	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
	7-17	Sandy loam, loam, coarse sandy loam.	SM, SC, SC-SM	A-2, A-4, A-6	0	90-100	85-100	50-80	20-45	<40	NP-15
	17-60	Gravelly coarse sand, sand, gravelly loamy sand.	SP-SM, GP, SM, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-15	---	NP
77B-------------- Nutley	0-7	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
	7-60	Clay, silty clay, clay loam.	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
79F*:											
Arvilla---------	0-7	Sandy loam-------	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
	7-17	Sandy loam, loam, coarse sandy loam.	SM, SC, SC-SM	A-2, A-4, A-6	0	90-100	85-100	50-80	20-45	<40	NP-15
	17-60	Gravelly coarse sand, sand, gravelly loamy sand.	SP-SM, GP, SM, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-15	---	NP
Sioux-----------	0-6	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	6-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
81C, 81F: Wabek	0-7	Sandy loam	SM	A-2, A-4	0-1	85-100	85-100	60-70	30-40	---	NP
	7-60	Gravelly loamy sand, very gravelly coarse sand.	GM, SM, SP, SW	A-1	0-1	25-90	10-65	5-35	0-25	---	NP
83B*:											
Williams	0-6	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells	0-8	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	20-40	3-23
	8-20	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
	20-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
86C*:											
Williams	0-6	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Zahl	0-5	Loam	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-16	Loam, clay loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30
	16-60	Clay loam, loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30
95*. Pits, sand and gravel											
99C*:											
Williams	0-6	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Zahl	0-5	Loam	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-16	Loam, clay loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30
	16-60	Clay loam, loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30
Parnell	0-7	Silt loam	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	7-37	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	37-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
99F*:											
Zahl	0-5	Loam	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-16	Loam, clay loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30
	16-60	Clay loam, loam	CL, CL-ML	A-6, A-4, A-7	0-1	90-100	85-100	80-95	55-80	25-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
99F*:											
Williams--------	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-15	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	15-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Parnell---------	0-7	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	7-37	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	37-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
2----------------- Marysland	0-9	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
	9-24	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	24-60	6.0-20	0.02-0.07	7.9-8.4	<2	Low--------	0.15		
6----------------- Harriet	0-1	0.06-0.2	0.20-0.24	6.6-8.4	<2	Moderate	0.37	3	6
	1-9	0.06-0.2	0.10-0.15	>7.3	4-16	High-------	0.37		
	9-42	0.06-0.2	0.10-0.15	>7.8	4-16	Moderate	0.37		
	42-60	2.0-20	0.05-0.10	>7.8	4-16	Low--------	0.15		
7----------------- Fossum	0-17	6.0-20	0.10-0.12	7.4-8.4	<2	Low--------	0.17	5	2
	17-24	6.0-20	0.06-0.11	7.4-8.4	<2	Low--------	0.17		
	24-60	6.0-20	0.05-0.09	7.4-8.4	<2	Low--------	0.17		
10---------------- Southam	0-6	0.2-0.6	0.18-0.23	6.6-8.4	2-8	Moderate	0.37	5	4L
	6-60	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High-------	0.28		
11---------------- Parnell	0-7	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	7-37	0.06-0.2	0.13-0.19	6.1-7.8	<2	High-------	0.28		
	37-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
12*:									
Parnell----------	0-7	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	7-37	0.06-0.2	0.13-0.19	6.1-7.8	<2	High-------	0.28		
	37-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
Vallers----------	0-7	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low--------	0.28	5	4L
	7-20	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28		
	20-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28		
15---------------- Divide	0-8	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28	4	4L
	8-30	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low--------	0.28		
	30-60	6.0-20	0.03-0.07	7.4-8.4	<2	Low--------	0.10		
18*:									
Fram-------------	0-31	0.6-2.0	0.14-0.17	7.4-8.4	4-16	Low--------	0.28	5	4L
	31-60	0.6-2.0	0.09-0.14	7.4-8.4	4-16	Low--------	0.37		
Vallers----------	0-7	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low--------	0.28	5	4L
	7-20	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low--------	0.28		
	20-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low--------	0.28		
19---------------- Tonka	0-21	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low--------	0.32	5	6
	21-49	0.06-0.2	0.14-0.19	5.6-7.8	<2	High-------	0.43		
	49-60	0.2-0.6	0.14-0.19	6.6-8.4	<2	Moderate	0.43		
23---------------- Marysland	0-9	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
	9-24	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	24-60	6.0-20	0.02-0.07	7.9-8.4	<2	Low--------	0.15		
24C*:									
Barnes-----------	0-5	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low--------	0.28	5	6
	5-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse-------------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
26B*:									
Barnes----------	0-5	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	5-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-23	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	23-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Cresbard--------	0-6	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	6-27	0.06-0.6	0.11-0.14	5.6-7.8	2-4	High------	0.32		
	27-44	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	44-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
30*:									
Svea------------	0-8	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-26	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	26-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-5	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	5-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
30B*:									
Barnes----------	0-5	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	5-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Svea------------	0-8	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-26	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	26-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
32C*, 32F*:									
Barnes----------	0-5	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	5-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse------------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Parnell---------	0-7	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-37	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	37-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
35B-------------- Overly	0-10	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	10-42	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	42-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
36D*, 36F*:									
Buse------------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-5	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	5-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
37B*:									
Cresbard--------	0-6	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	6-27	0.06-0.6	0.11-0.14	5.6-7.8	2-4	High------	0.32		
	27-44	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	44-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
37B*:									
Cavour----------	0-8	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	8-46	<0.2	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	46-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
38--------------- Miranda	0-1	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low-------	0.32	3	6
	1-21	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	21-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
40F. Orthents, loamy									
41C*, 41E*:									
Towner----------	0-8	2.0-6.0	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	8-30	2.0-6.0	0.06-0.13	6.6-7.8	<2	Low-------	0.17		
	30-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
Maddock---------	0-11	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	11-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low-------	0.17		
Buse------------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
42B-------------- Towner	0-8	2.0-6.0	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	8-30	2.0-6.0	0.06-0.13	6.6-7.8	<2	Low-------	0.17		
	30-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
44B-------------- Swenoda	0-7	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	0.20	5	3
	7-31	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	0.20		
	31-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
45B*:									
Cathay----------	0-7	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low-------	0.32	3	5
	7-22	0.2-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	0.32		
	22-60	0.6-2.0	0.17-0.19	7.4-9.0	4-8	Moderate	0.32		
Emrick----------	0-8	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	5
	8-22	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	0.28		
	22-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low-------	0.37		
46*:									
Larson----------	0-8	0.6-2.0	0.16-0.24	6.1-7.3	<2	Moderate	0.32	3	5
	8-23	0.06-0.2	0.10-0.14	6.6-9.0	4-16	Moderate	0.32		
	23-60	0.2-2.0	0.12-0.16	7.9-9.0	2-8	Moderate	0.32		
Cathay----------	0-7	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low-------	0.32	3	5
	7-22	0.2-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	0.32		
	22-60	0.6-2.0	0.17-0.19	7.4-9.0	4-8	Moderate	0.32		
53B-------------- Renshaw	0-6	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low-------	0.28	3	5
	6-15	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low-------	0.28		
	15-60	>20	0.03-0.06	6.6-8.4	<2	Low-------	0.10		
54B-------------- Arvilla	0-7	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low-------	0.20	3	3
	7-17	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low-------	0.20		
	17-60	>20	0.02-0.05	7.4-8.4	<2	Low-------	0.10		
57*:									
Hamerly---------	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-28	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
57*:									
Tonka	0-21	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low	0.32	5	6
	21-49	0.06-0.2	0.14-0.19	5.6-7.8	<2	High	0.43		
	49-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
62*, 62B*:									
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-18	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	18-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
Emrick	0-8	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	5
	8-22	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	22-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low	0.37		
63D*, 63F*:									
Esmond	0-4	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	4-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-18	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	18-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
64C*:									
Heimdal	0-7	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	7-18	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	18-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
Esmond	0-4	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	4-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
65B Maddock	0-11	6.0-20	0.08-0.12	6.6-7.8	<2	Low	0.17	5	2
	11-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	0.17		
67B Lehr	0-7	0.6-6.0	0.17-0.22	6.6-7.8	<2	Low	0.28	3	5
	7-15	0.6-6.0	0.17-0.20	6.6-8.4	<2	Moderate	0.28		
	15-60	>20	0.02-0.04	7.4-8.4	<2	Low	0.10		
73D*, 73F*:									
Zahl	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	5-16	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	16-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
Williams	0-6	0.6-2.0	0.17-0.24	6.6-7.8	<2	Low	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate	0.37		
74 Fram	0-31	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low	0.28	5	4L
	31-60	0.6-2.0	0.13-0.20	7.4-8.4	<2	Low	0.37		
75*:									
Fram	0-31	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low	0.28	5	4L
	31-60	0.6-2.0	0.13-0.20	7.4-8.4	<2	Low	0.37		
Tonka	0-21	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low	0.32	5	6
	21-49	0.06-0.2	0.14-0.19	5.6-7.8	<2	High	0.43		
	49-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
76C*:									
Sioux	0-6	2.0-6.0	0.18-0.20	6.6-8.4	<2	Low	0.28	2	5
	6-12	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low	0.20		
	12-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low	0.10		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
76C*:									
Arvilla	0-7	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low	0.20	3	3
	7-17	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low	0.20		
	17-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.10		
77B Nutley	0-7	0.06-0.2	0.10-0.16	6.6-8.4	<2	High	0.28	5	4
	7-60	0.06-0.2	0.08-0.15	7.4-8.4	<2	High	0.28		
79F*:									
Arvilla	0-7	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low	0.20	3	3
	7-17	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low	0.20		
	17-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.10		
Sioux	0-6	2.0-6.0	0.18-0.20	6.6-8.4	<2	Low	0.28	2	5
	6-12	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low	0.20		
	12-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low	0.10		
81C, 81F Wabek	0-7	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low	0.20	2	3
	7-60	>20	0.02-0.04	7.4-8.4	<2	Low	0.10		
83B*:									
Williams	0-6	0.6-2.0	0.17-0.24	6.6-7.8	<2	Low	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate	0.37		
Bowbells	0-8	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low	0.28	5	6
	8-20	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate	0.28		
	20-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate	0.37		
86C*:									
Williams	0-6	0.6-2.0	0.17-0.24	6.6-7.8	<2	Low	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate	0.37		
Zahl	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	5-16	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	16-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
95*. Pits, sand and gravel									
99C*:									
Williams	0-6	0.6-2.0	0.17-0.24	6.6-7.8	<2	Low	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate	0.37		
Zahl	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	5-16	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	16-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
Parnell	0-7	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low	0.28	5	6
	7-37	0.06-0.2	0.13-0.19	6.1-7.8	<2	High	0.28		
	37-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	0.28		
99F*:									
Zahl	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	5-16	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	16-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
99F*:									
Williams--------	0-6	0.6-2.0	0.17-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	6-15	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	15-60	0.2-0.6	0.15-0.18	7.4-8.4	<2	Moderate	0.37		
Parnell---------	0-7	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-37	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	37-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "occasional," "long," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
2------------------ Marysland	B/D	None--------	---	---	0-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
6------------------ Harriet	D	Occasional	Long------	Apr-Jun	0-1.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
7------------------ Fossum	A/D	None--------	---	---	1.0-2.5	Apparent	Nov-Oct	Moderate	High-----	Low.
10----------------- Southam	D	None--------	---	---	+5-1.0	Apparent	Jan-Dec	High-----	High-----	Low.
11----------------- Parnell	C/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	High-----	High-----	Low.
12*:										
Parnell----------	C/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	High-----	High-----	Low.
Vallers----------	C	None--------	---	---	1.0-2.5	Apparent	Nov-Jun	High-----	High-----	Low.
15----------------- Divide	B	None--------	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High-----	Low.
18*:										
Fram-------------	B	None--------	---	---	2.0-4.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
Vallers----------	C	None--------	---	---	0-1.0	Apparent	Apr-Jul	High-----	High-----	Moderate.
19----------------- Tonka	C/D	None--------	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
23----------------- Marysland	B/D	Occasional	Brief-----	Mar-Jul	0-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
24C*:										
Barnes-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Buse-------------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
26B*:										
Barnes-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Cresbard---------	C	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Moderate.
30*:										
Svea-------------	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
Barnes-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
30B*:										
Barnes-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Svea-------------	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
32C*, 32F*:										
Barnes-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
32C*, 32F*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
35B Overly	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	High	High	Low.
36D*, 36F*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
37B*:										
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Cavour	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
38 Miranda	D	None	---	---	2.0-4.0	Apparent	Apr-Jul	Moderate	High	Moderate.
40F. Orthents, loamy										
41C*, 41E*:										
Towner	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
42B Towner	B	None	---	---	>6.0	---	---	Moderate	High	Low.
44B Swenoda	B	None	---	---	>6.0	---	---	Moderate	High	Moderate.
45B*:										
Cathay	C	None	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Emrick	B	None	---	---	>6.0	---	---	Moderate	High	Low.
46*:										
Larson	D	None	---	---	3.0-6.0	Apparent	Mar-Jun	Moderate	High	Moderate.
Cathay	C	None	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate	High	Moderate.
53B Renshaw	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
54B Arvilla	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
57*:										
Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
62*, 62B*:										
Heimdal	B	None	---	---	>6.0	---	---	Moderate	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
62*, 62B*:										
Emrick----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
63D*, 63F*:										
Esmond----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Heimdal---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
64C*:										
Heimdal---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Esmond----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
65B-------------- Maddock	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
67B-------------- Lehr	B	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
73D*, 73F*:										
Zahl------------	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
Williams--------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
74--------------- Fram	B	None--------	---	---	2.0-6.0	Apparent	Sep-Jun	High-----	High-----	Low.
75*:										
Fram------------	B	None--------	---	---	2.0-6.0	Apparent	Sep-Jun	High-----	High-----	Low.
Tonka-----------	C/D	None--------	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
76C*:										
Sioux-----------	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
Arvilla---------	B	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
77B-------------- Nutley	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
79F*:										
Arvilla---------	B	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
Sioux-----------	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
81C, 81F--------- Wabek	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
83B*:										
Williams--------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Bowbells--------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
86C*:										
Williams--------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Zahl------------	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
95*. Pits, sand and gravel										

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
99C*:										
Williams	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Zahl	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
99F*:										
Zahl	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
Williams	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

(Dashes indicate that data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic)

Soil name, report number, horizon, and depth in inches*	Classification		Grain-size distribution								Moisture density	
			Percentage passing sieve--					Percentage smaller than--	LL	PI	MD	OM
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No 200	.005 mm				
									Pct		Lb/ cu ft	Pct
Arvella sandy loam:												
(S86ND083-042)												
Bw1---- 6 to 15	A-4(0)	SC	99	99	97	74	36	10	25	8	132	8
2C----- 20 to 60	A-1-a(0)	GP-GM	58	48	40	25	8	2	---	NP	132	9
Divide loam:												
(S87ND083-060)												
Bk----- 15 to 25	A-6(3)	SC	97	96	93	81	46	21	30	13	123	11
2C2---- 30 to 60	A-3(0)	SP-SM	98	94	87	70	9	2	---	NP	124	11
Emrick loam:												
(S86ND083-041)												
Bw2---- 16 to 24	A-4(2)	CL	100	99	98	93	59	16	26	8	125	11
C------ 41 to 60	A-4(0)	SM	100	99	95	86	44	10	---	NP	130	9
Esmond loam:												
(S86ND083-061)												
Bk2---- 14 to 29	A-4(2)	CL	97	97	93	84	50	19	29	10	122	12
C------ 39 to 60	A-6(3)	SC	95	94	88	83	51	18	30	13	125	11
Heimdal loam:												
(S86ND083-040)												
Bw2---- 11 to 18	A-4(3)	CL	99	99	97	94	62	16	29	9	123	11
C------ 30 to 60	A-6(3)	CL	98	97	94	87	53	19	27	11	126	10
Larson loam:												
(S87ND083-052)												
Bt2---- 14 to 25	A-6(9)	CL	100	100	89	85	61	28	35	19	122	12
Bk----- 25 to 45	A-6(5)	CL	100	99	93	87	56	25	29	14	127	10
Lehr loam:												
(S87ND083-045)												
Bw2---- 10 to 15	A-6(3)	SC	99	98	93	83	45	17	32	13	125	11
2C----- 15 to 60	A-1-a(0)	SP-SM	62	50	39	24	7	2	---	NP	130	9

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
*Bowbells	Fine-loamy, mixed Pachic Argiborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cathay	Fine-loamy, mixed Glossic Udic Natriborolls
Cavour	Fine, montmorillonitic Udic Natriborolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Emrick	Coarse-loamy, mixed Pachic Udic Haploborolls
Esmond	Coarse-loamy, mixed Udorthentic Haploborolls
*Fossum	Sandy, mixed (calcareous), frigid Typic Haplaquolls
Fram	Coarse-loamy, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Harriet	Fine, montmorillonitic, frigid Typic Natraquolls
Heimdal	Coarse-loamy, mixed Udic Haploborolls
Larson	Fine-loamy, mixed Udic Natriborolls
Lehr	Fine-loamy over sandy or sandy-skeletal, mixed Typic Haploborolls
*Maddock	Sandy, mixed Udorthentic Haploborolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Miranda	Fine-loamy, mixed Leptic Natriborolls
Nutley	Fine, montmorillonitic Udertic Haploborolls
Orthents	Orthents
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wabek	Sandy-skeletal, mixed Entic Haploborolls
Williams	Fine-loamy, mixed Typic Argiborolls
Zahl	Fine-loamy, mixed Entic Haploborolls

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